SUBCONTRACTOR SELECTION CRITERIA FOR CONSTRUCTION PROJECTS IN SAUDI ARABIA

BY

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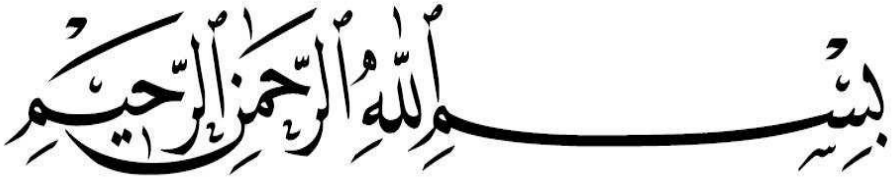

In the Name of Allāh, the Most Gracious, the Most Merciful

Dedication

In the Name of Allah, the most Gracious, the most Merciful.

"… Verily, my salat (prayer), my sacrifice, my living, and my dying are for **ALLAH**, the Lord of the 'Alamin (mankind, jinn and all that exists)" Qur'an 6: 162.

I Solely Dedicate my Thesis to My Beloved Parents.

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LIST OF ABBREVIATIONS

ASCE	**:**	American Society of Civil Engineers
EPC	**:**	Engineering, Procurement, Construction
LSTK	**:**	Lump sum turnkey
OSHA	**:**	Occupational Safety and Health Administration
SAS	**:**	Statistical Analysis System
SPSS	**:**	Statistical Package for Social Sciences

THESIS ABSTRACT - ENGLISH

Full Name : Meer Aijaz Ali

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Subcontracting is used much more extensively on housing and building construction projects than on engineering and industrial projects. On many projects, especially building projects, it is common for 80 to 90% of the work to be performed by subcontractor. Subcontracting is widely consider as an avenue to optimize costs, redistribute the contractor's workload and rationalize their in-house manpower**.** The aim of this study is to identify the subcontractor selection criteria for construction projects in Saudi Arabia. The scope of this study is to determine the subcontractor selection criteria for housing and building construction projects in Saudi Arabia. It will also address the complications being faced by contractors and determine their effects on project performance. Subcontractor performance is as an important index used by general contractors to select optimal subcontractor. Subcontractor performance is affected by different expected and/or unexpected factors, such as management ability, worksite condition and subjective assessment. A questionnaire accompanied with a covering letter was delivered to contracting companies in person. Data obtained from the questionnaire was analyzed and used to identify the significant subcontractor selection criteria and that are considered important by the construction contractors in the Eastern Province of Saudi

Arabia. Statistical method such as SPSS software was used to interpret the results. It was found that tender price, project management organization and length of time in business are the most significant subcontractor selection criteria.

THESIS ABSTRACT - ARABIC

الاسم الكامل : مـير إعجاز عـلي

عنوان الرسالة :الـ بـناء فـي الـمملـكة الـعربـية الـسعوديـة ريـعمـشامعايـير الاخـتـيار الـ باطن

التخصص : هندسة البناء وإدارة

تاريخ الدرجة العلمية : يـونـيو 2015

الإ سكان مـشاريـع فـي واسع نـطاق عـلى بـكـثـير ذلـك من أكـثر الـ باطن من الـ تعاقـد ويـسـتخدم من الـعديـد فـي .صـناعـيةوال الـهندسـية الـمشاريـع عـلى الـ تركـيز من الـمبانـي وتـشـيـيد الـ قـيامـيـ تـعـين الـذي الـعمل من ٪90 إلـى 80 لـمدة الـ شائـع ومن الـمشاريـع، بـ ناء وخاصة الـمشاريـع، الـ نـفقات، لـخـفض كـوسـيلة واسع نـطاق عـلى يـ نظر الـ باطن من والـ تعاقـد .الـ باطن قـبل من بـها هذه من فـوالـهد .بـهم الـمنزل فـي الـعاملة الـقوى وتـرشـيد والـمـقاول الـعمل عبـء تـوزيـع إعادة الـعربـية الـمملـكة فـي الـ بـناء لـمشاريـع الـ باطن من الـمـقاول اخـتـيار معايـير تـحديـد هو الـدراسة الإ سكان لـمشاريـع الـ باطن من مـقاول اخـتـيار معايـير تـحديـد هي الـدراسة هذه نـطاق .الـ سعوديـة الـمـقاولـين يـواجهها الـ تـي الـ تـعـقـيدات سـتـتناول كما .الـ سعوديـة الـعربـية الـمملـكة فـي والـ بـناء قـبل من الـمسـتخدمة مهم مؤشر بـمـثابـة هو الـ باطن أداء .الـمشروع أداء عـلى آثـارها وتـحديـد غـير أو / و الـمـتوقـعة بـعوامل الـ باطن أداء يـ تأثـر .الأمـثل الـ باطن لـ تحديـد الـعامة الـمـقاولـين تـسـليم وتـم .شخصي وتـقـيـيم الـعمل موقـع شرط الإدارة، عـلى الـ قدرة مـثل مخـتـلفة، مـتوقـعة تـم الـ تـي الـ بـيانات تـحـليل تـم .شخص فـي الـمـقاولات لـ شركات بـ خطاب امصحوب الا سـتـبـيان تـعـتـبر والـ تـي الـ باطن اخـتـيار هلمة معايـير لـ تحديـد وتـسـتخدم الا سـتـبـيان من عـليها الـحصول تـم .الـ سعوديـة الـعربـية الـمملـكة من الـ شرقـية الـمنطـقة فـي الـ تـشـيـيد مـقاولـي قـبل من الـمهم الـعطاء، سعر أن وجد فـقد .الـ نـتائـج تـفسـيرل SPSS بـرنـامج مـثل إحـصائـية طريـقة اسـتخدام .الـ باطن اخـتـيار أهـية الأكـثر الـمعايـير هي الـعمل فـي الـوقـت وطول الـمشاريـع إدارة وتـنظـيم

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The construction business is active in nature owing to the growing improbabilities in technology advancement, knowledge, resources, budgets and growth and expansion processes. Today, construction ventures are becoming extensively more complicated and challenging. Because of the greater than before project difficulty and the extremely modest quality of the construction business, a building venture seldom is performed by numerous subcontractor. A subcontractor is a construction organization that has agreement with a main contractor to execute particular part of the contractor's work. In largely construction projects, a vital role is played by subcontractor who are hired to perform specific tasks on a project. In the usual case, the general contractor will perform the basic operations and subcontract the remainder to various specialty contractors.

Subcontracting is used much more extensively on housing and building construction projects than on engineering and industrial projects. On many projects, especially building projects, it is common for 80 to 90% of the work to be performed by subcontractor (Arditi, & Chotibhongs, 2005). The contribution of specialist and trade subcontractor to the total construction process can account for as much as 90% of the total value of the project, while the incidence and importance of subcontracting in Hong Kong is similar (M. Kumaraswamy, Mohan and D. Matthews, 2000).

Subcontractor can contribute to the construction process for as much as 90% of total project value (Wang & Liu, 2005). (Laryea & Lubbock, 2014) indicates that between 70 and 85% percent of construction work may be subcontracted. Research by (Arditi, Asce, & Chotibhongs, 2005b) found that up to 70% of construction work is normally subcontracted in Saudi Arabia.

Subcontracting signifies to an agreement whereby a contractor allows another firm (a subcontractor) to assume part of work he has obtained with the owner (Lehtinen, 2001). Subcontract arrangements are widely used in construction because of the structure of the industry, the industry's workload is highly diversified by type, size, function, form and method of production, and materials used. The study related to subcontractor has rarely been done in Saudi Arabia, so these make this research more important to understand their role in construction industry and contribute to the knowledge of understanding subcontractor in construction projects. According to (M. Kumaraswamy, and D. Matthews, 2000) subcontracting is widely consider as an avenue to optimize costs, redistribute the contractor's workload and rationalize their in-house manpower**.** It also helps to utilize already available resources in the market, diversify against risk, lower operation costs, obtain competitive advantage and inquire for the most satisfactory profit base.

1.2 STATEMENT OF THE PROBLEM

One of the important factors in any successful construction project is the right choice of an appropriate subcontracting strategy which assembles a perfect team for the construction work with an expedient allocation of work items, schedule and resources.

Subcontractor have also caused problems. With easy entry into the construction market place in the U.K., subcontractor organizations have been established with very little capital investment. Many of these subcontractor companies do not have the necessary expertise to undertake work satisfactorily and, as a consequence, are unable to give their clients the service they require. Moreover, many of the bad traits common to the main contractor– subcontractor relationship are also common to the subcontractor–sub-subcontractor relationship (M. Kumaraswamy and D. Matthews, 2000).

Many subcontractor are small, family-owned businesses. They may suffer from underfinancing, understaffing, or have limited managerial and technical skills. It is also potentially problematic that, often, a supervisor is the highest ranking employee on a jobsite. Many supervisors have not had the opportunity to learn expert managerial practices, and this lack of knowledge can negatively affect the project (Thomas, & Flynn, 2011).

Safety is another aspect of subcontractor' practices that is often subpar. Many construction companies have different views and practices when dealing with the issue of safety. Much of the time, subcontractor have low standards for safety that do not meet the requirements of the construction manager or general contractor(Thomas et al., 2011a).

Due to these problems there is a need for some criteria that should be seen or can be kept as prequalification in every subcontractor before handling the project.

Hence, it is relevant to ask the following questions which make up the basic research question that this study attempts to provide answers to:

1.3 RESEARCH QUESTIONS

1. How is subcontracting conducted in construction projects in Saudi Arabia?
2. What are the main criteria in selecting subcontractor?
3. How these criteria influence the performance of the project?

1.4 RESEARCH AIM

The research aim of this study is to identify the subcontractor selection criteria for construction projects in Saudi Arabia.

1.5 SIGNIFICANCE OF THE STUDY

The selection and designation of work item to subcontractor is very crucial to the successful execution of any construction project. The fact that the underlying factors vary with the contractor's organization and are often project specific usually complicates the problems. However, in practice, there is no definite approach to explain the procedure.

The study of the subcontractor' selection criteria for construction projects in Saudi Arabia will be helpful in the following ways:

1. Can establish the scope of subcontracting practices of contractors on construction projects in Saudi Arabia for the benefit of the entire construction industry.

2. Improve the practices of contractors by providing knowledge of the criteria for selection of subcontractor and their decisions on construction projects.

1.6 SCOPE AND LIMITATIONS

The scope of this study is to determine the subcontractor' selection criteria for housing and building construction projects in Saudi Arabia. It will also address the complications being faced by contractors and determine their effects on project performance. These contractors undertake the construction of a wide range of facilities within the Kingdom of Saudi Arabia and beyond. The Building Industry is chosen because it is the largest industrial and commercial work for any construction company in Saudi Arabia.

Although design-build/engineer, procure, construct (EPC) contracting can potentially save millions of dollars up front, as well as dollars paid in change orders while construction proceeds, design-build/EPC contracting may not be the silver bullet for construction that design-build/EPC contractors perceive it to be. Owners often question whether the checks and balances are in place and question who really pays for alterations in design. Owners look toward the design-build/EPC contractor to be the one-stop shop and the last stop for all the costs to be incurred for a project—from inception to project closeout. Thus, change becomes an issue that may not be well defined in today's design build/ EPC construction environment(Galloway, 2009) .

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature review in this part discussed about the subcontractor. The discussions are divided into four parts. The first part discusses the basics of subcontracting and its importance in today's construction industry; the second part discusses the problems that occur in subcontracting the works which finally leads us to the problem of selecting the subcontractor and the need to have certain criteria for selection of a flawless subcontractor. The third part discusses the different criteria for selecting subcontractor and last part briefly gives the conclusion which leads us to the research questions.

2.2 IMPORTANCE OF SUBCONTRACTOR

Subcontracting refers to an arrangement whereby a contractor authorizes another firm (a subcontractor) to undertake part of work he has secured with the owner (Lehtinen, 2001). According to (Kimura, 2002), the relationship is often between an upstream larger firm and a downstream smaller firm and it is not exclusive as the subcontractor may have many customers among the contractors.

Despite the increasing extent of subcontracting in construction, the importance of subcontractor selection is frequently underestimated. While the subcontracting element

needs more attention in contractor selection itself, subcontractor selection techniques themselves need considerable improvements.

Mbachu (2008) and Al-Hammad (1993) indicate that between 70 and 85% percent of construction work may be subcontracted. Research by Al-Hammad (1993) found that up to 70% of construction work is normally subcontracted in Saudi Arabia. Subcontractor help general contractors to overcome problems related to the need for special expertise, shortage in resources, and limitation in finances(B. A. M. Elazouni, Member, & Metwally, 2000). The operations of the average general contractor are not sufficiently extensive to afford full-time employment of skilled craftsmen in each of the several trade classifications needed in the field(Arditi et al., 2005b). Subcontracting allows general contractors to employ a minimum workforce in construction projects and promotes specialization. Qualified subcontractor are usually able to perform their work specialty more quickly and at a lesser cost than can the general contractor(Arditi et al., 2005b).

Subcontracting can also be refers to the purchase of a part or component of a product or process from a different firm (Kimura, 2002). Specifically, subcontracting means long term transactions with specific companies, in which the firm offering another independent enterprise the subcontract requests to undertake the production or carry out the processing of a material, component, part or subassembly for it according to specifications or plans provided by the firm offering the subcontract (Holmes, 1986, p.84; Taymaz & Kiliçaslan, 2005, p.634). Because subcontracting has become a standard procedure in contemporary construction (Eccles 1981; Birrell 1985; Gray and Flanagan 1989; Hinze and Tracey 1994), it is highly questionable that much productivity

improvement can be achieved if this vital factor continues to be either ignored or mishandled in the study framework.

Since subcontractor secure virtually all their work through general contractors, the success of the typical subcontractor depends directly on the relationships they establish and maintain with those general contractors that need their expertise. Once the relationship is established, most subcontractor work with the same general contractors on a regular basis and they tend to maintain the relationship over time. (Shash, 1998) Stated that "general contractors and subcontractor may not cooperate in a highly recurrent way; nevertheless they entertain long term business relations" (p. 446). Statistics presented in the publication indicate that 76% of commercial subcontractor have maintained their relationships with general contractors for an average of 21.1 years(Shash, 1998) .

2.3 REASONS FOR SUBCONTRACTING

Subcontract arrangements are widely used in construction because of the structure of the industry. The industry's workload is highly diversified by type, size, function, form and method of production, and materials used. The execution of the works demand the services of many different trade specialists, hence the industry is dominated by a large number of small companies which provide subcontract services to their larger counterparts (Edum-Fotwe, McCaffer, & Majid, 1999). Everyday economic facts justify the use of subcontracting because it utilizes the resources efficiently and economically. Generally, the activities of contractors are not extensive enough to sustain full-time employment of skilled workers in all the available trade classifications necessary in the construction field. Also it is impracticable for these companies to possess, operate and

maintain specialized equipment that may have little use during a project (Arditi et al., 2005b).

Subcontracting is widely consider as an avenue to optimize costs, redistribute the contractor's workload and rationalize their in-house manpower (M. Kumaraswamy, and D. Matthews, 2000). Subcontracting helps to utilize already available resources in the market, diversify against risk, lower operation costs, obtain competitive advantage and inquire for the most satisfactory profit base(Tserng & Lin, 2002). Subcontract works often entail the use of special method, delivery of proprietary products, or works that can only be executed by registered or licensed companies which may also involve a certain amount of design input (Yik & Lai, 2008). Construction sites are often geographically dispersed and itinerant workforce is uncommon, making it imperative to contractors to sublet works to local subcontractor who have resident workforce(Mudorch J: Hughes. W, 2008)

Non-performance of any subcontracting firm can be a chief cause of project failure since a significant proportion of construction work is done by subcontractor(Arditi et al., 2005b). (González-Díaz, Arruñada, & Fernández, 2000) examined factors explaining subcontracting decisions in the construction industry using evidence from panel data on construction firms. The result revealed that firm subcontract more when engage in heterogeneous work which required diverse expert knowledge and equipment's and subcontract less as specificity grows.

2.4 SUBCONTRACTING SYSTEM

Two basic structures of subcontracting were identified by (Lehtinen, 2001), the star shaped and the tiered or clustered structure. In star-shaped structure, the subcontractor have direct contact with the contractor who plays a central role in the flow of information. In tiered structure, few subcontractor who have direct contact with the contractor later sublet the contract down the chain.

(Yik & Lai, 2008) studied how multilayer subcontracting systems works in the Hong Kong building construction industry. The study revealed that the system is highly effective in mobilizing workers to cope with fluctuating labor demand and ensuring workers effective performance but plagued by non-payments for lower tier subcontractor and workers which often lead to project delays and substandard quality performance.

(Tam, Shen, & Kong, 2011) investigated the effects of the multilayer subcontracting system on project performance and established inverse correlation between the numbers of layers in the chain and project performance. He recommended a restrain in the number of subcontracting layers as a remedy to the associated poor quality, schedule and cost performance on projects utilizing such system. The poor communication, lack of coordination, poor supervision of bottom layer subcontractor, diffusion of accountability for work within the hierarchy of subcontractor were some of the reasons identified as the causes of poor performance inherent on projects utilizing multi-layer subcontracting system.

Buyout period is the time between the contract award to the contractor and the subcontracts being awarded, it is a transitional time between the preconstruction and the construction phases of a project during which subcontracts and purchase orders are issued (Zwick & Miller, 2004). Most subcontractor are selected close to the time they are to start their own portion of the work, in essence the time for issuing the subcontract is very short, this often leads to poor communication between the parties, impetuousness and complications in making the optimum choice of subcontractor which breeds hostility later on the project (Tserng & Lin, 2002).

It is requiring of subcontractor executing their work in line with the schedule of the contractor. They should have a copy of the project schedule indicating the exact dates their work is scheduled and the time allocated for the execution. Contractors often inform each of their subcontractor by letter two weeks or more ahead of the date of commencement of their operations. Subcontractor should not be schedule to be on site until the job is ready and the subcontract work can proceed uninterrupted. Progress of work of the subcontractor should be monitored and ensured it is in pace with the project schedule (Queiroz, 1999).

2.4.1 EFFECTS OF SUBCONTRACTING ON PROJECTS

Subcontractor' provide specialist construction services thereby absorbing the fluctuating workloads of contractors(Hinze j, 2001). In recent years, most engineering functions and values of a project are executed by specialized engineering firms or subcontractor who de

facto employ the actual builders and direct labor to carry out the work while the contractor functions as the project coordinator or manager (Tserng & Lin, 2002).

Boundless subcontracting can upset the overall scheduling of job operations, precipitate grave segmentation of project authority, fragmentize responsibility, make the coordination of construction activities herculean, cripple communication between management and site, encourage disputes, and be generally detrimental to job efficiency(Clough, hr; Sears, 2005). (Chiang, 2009) reviewed the consequence of high and increasing growing rate of subcontracting in building industry in Hong Kong. The negative impacts such as weak bargaining power of subcontractor, vulnerability to bankruptcies, and non-payment to workers, labor intensity, lackluster quality performance and negligent safety practices were mentioned while the specialized services as well as organizational and managerial flexibility provided by the subcontractor were acknowledged.

2.4.2 CONTRACTORS-SUBCONTRACTOR RELATIONSHIP

The practice in subcontracting for a designated subcontract work is that the contractor invite subcontractor to submit price quotations, he then evaluates the submitted quotations and select one to be used for bidding. After the award of the contract, he then awards the sublet work to either the subcontractor whose quotation was used in the bid or to a different subcontractor(Shash, 1998).

Hinze j, 1994 Conducted an exploratory study on contractor-subcontractor relationship, the result revealed a more adversarial situation with a large amount of mistrust and

insufficient communication. Relationship between subcontractor and the contractor are often strained and liable to cause conflicts due to poor sense of fairness and misunderstanding of each other's. In order to coordinate the subcontractor work with that of other subcontractor, the contractor must know each subcontractor work in detail (Olson, 1998).

Hsieh, 1998 established that the gap between contractors and subcontractor has a negative impact on site productivity. (Proctor, 1996) emphasized the importance of the four C's; Consideration, Communication, Cooperation and Compensation during contract negotiation and execution as the golden rule of contractor-subcontractor relation. He emphasized the need for the subcontractor to understand the complete scope of work of the general contractor as well as the methods and schedule by which the general contractor plans to execute the project ahead of submission of proposal.

According to (Love, 1997), the ideal subcontractor (as viewed by the contractors): is honest about mistakes, innovative and creative, adheres to schedules, fairly resolves impacts and change orders, produces work of high quality, has fully supported invoices, works in the best interest of the project, flexible to reasonable changes, helps the project beyond his own scope of work, comes in under budget, has a well trained workforce, is thoroughly familiar with the terms and conditions of the contract, identifies needs in timely fashion and has a perfect safety program.

Similarly, an ideal contractor (as viewed by subcontractor): accepts responsibility, is flexible and open to suggestions, gives accurate information for scheduling and coordinating, is fair and honest with compensation for changes, demands quality, pays promptly, has no hidden agendas, treat subcontractor equally, presents a reasonable and

logical schedule, makes decisions and resolves conflicts in timely fashion, has a defined chain of command and shows faith and trust in subcontractor experience (Love, 1997).

In a study, (Lee, Seo, Park, Ryu, & Kwon, 2009) identified three relationship types between the contractor and the subcontractor namely: competitive relationship – also referred to as distributive, win – lose, or adversarial relationships, its' used to transfer the associated risks to other project participants, it diminishes subcontractor' bargaining power with the contractor and often results in unfair contractual condition and onerous practices. The other two are strategic partnering and strategic partnership, both approaches highlight the need for close and long term relationship between contractors and subcontractor, the knowledge and experience gained through a sustained relationship can enhance cooperation and future collaboration which is built on trust, which results in a productive, win-win relationship.

However, the more the contractor relies on the technical skills of a specific subcontractor, the more cumbersome it becomes to control costs, the more mandatory it becomes to rely on specific producers; all these make it less likely that new technological skills or ideas will be accepted (Tserng & Lin, 2002).

2.4.3 CURRENT SUBCONTRACTOR SELECTION PROCESS

A reasonable amount of competition on time, price and quality is desirable for subcontractor selection; the contractor is likely to strike a better deal in the presence of competition among the subcontractor. However, negotiated approach has proof more valuable in situations such as; early start on site, continuation contract, business relationship, contractor specialization, financial arrangements, geographical situation etc.

Each project being specifically examined based on its features and the prevailing conditions (Ashworth, 2001). On public works, the names of contractors who obtained bid documents are usually made known to public, hence contractors do receive price quotations from some unfamiliar subcontractor. If the lowest price is from an unfamiliar firm, the contractor may decide to use a price submitted by a familiar firm as the objective is to submit a reliable and reasonable bid at which profit can be made (Hinze j, 2001).

Many contractors have a tendency to award a majority of their subcontracts to prefer subcontractor but this do discourage competing subcontractor. However it is advantageous to contractors to have a cordial relationship with several subcontractor associated with each work specialty (Clough, hr; Sears, 2005). Selecting subcontractor on a basis of lowest price often results in claims for extension of time, claims for additional fees, less trust between the parties, less investment in training and development, higher capital cost of construction and operation, and a reduced quality in workmanship (Lavelle, D., Hendry, J. and Steel, 2007).

Prequalification is the process of screening (sub)contractors to verify their competence to execute the project within the specified objective of time, budget and quality standard, it is also used to identify (sub)contractor groupings based on factors including size, resource capacity and suitability for particular project types. The groups are assigned to standing lists which are used to segregate the qualified (sub) contractor's bid for further financial scrutiny. This facilitates the identification of injudicious (sub) contractor at an early stage (A. M. Elazouni, 2007).

The most widely used (sub)contractor's pre-qualification criteria are financial stability, technical and management ability, experience, performance, resources, quality management, and health and safety concerns (El-Sawalhi, Eaton, & Rustom, 2007). Thomas Ng, Tang, & Palaneeswaran, 2009 also compiled 26 commonly used criteria for scrutinizing subcontractor structured under the above mentioned 8 aspects/issues.

According to (Arslan, Kivrak, Birgonul, & Dikmen, 2008), the need to evaluate subcontractor during the selection process becomes more salient as the project becomes more complicated as this plays an important role in the success of the project. He further developed a web-based subcontractor evaluation system which can be used by contractors to evaluate subcontractor based on certain combined criteria similar to some of the above mentioned.

Numerous research models exists for subcontractor/ suppliers selection, others researches listed the criteria and some went further by assigning weights to them. (Lavelle, D., Hendry, J. and Steel, 2007) is a rich source of previous works, he went ahead to test the theory that subcontractor are chosen mainly on the basis of price and the significance put on the selection criteria varies with project scenarios using five project scenarios of "in general, specialist packages, non-specialist packages, packages low in value and packages high in value" by using fourteen earlier used criteria in previous studies. He concluded that health and safety, past performance and insurance cover were considered equally important as price and in some scenarios more important than price.

(Hartmann, Yean, Ling, & Tan, 2010) using a choice-based conjoint experiment observed that the Singaporean contractors utilizes an unbalanced multi criteria selection which

gives preference to price ahead of quality, cooperation and technical know-how of a known subcontractor although they perceive all the four criteria to be important.

Recent researches in construction project management like the work of (Kumaraswamy, M.M. and Matthews, 2000), (Maturana, Alarcón, Gazmuri, & Vrsalovic, 2007), (Eom, Ph, Yun, & Paek, 2009) etc. advocates partnering between contractors and subcontractor as an effective method for subcontractor selection.

2.4.4 CURRENT SUBCONTRACTING PRACTICE

According to research done by (Zou & Lim, 2006), the current subcontracting practices can be seen with his results which shows the different forms of subcontracting practices that have been used by the main contractors interviewed in their research. The results shows that selective tendering (54.5%) is the most favorable manner followed by open tendering (26.1%) and direct negotiation is lease used(19.4%). (Zou & Lim, 2006) said that interviewees were aware of the high administration cost and time commitment associated with open tendering. Most interviewees consider selective tendering as "performance-based" or "preferred" tendering, where the selection of subcontractor are based on their past performance, reasonable price and their current workload. All interviewees have developed and maintained a list of preferred subcontractor. In addition, half of the interviewees stressed that "past performance" is associated to "past relationship" with their subcontractor.

The high percentage use of selective tendering indicates that there is a balance between the price and relationship elements in the selection of subcontractor. From the findings, it

may infer that the interviewees perceived relationship as an important role in subcontracting without compromising competition.

2.4.5 CRITERIA FOR SELECTING SUBCONTRACTOR

According to (Arslan et al., 2008) subcontractor are generally evaluated by four qualities which also become the main selecting criteria. These include: 1) Cost 2) Quality 3) Time and 4) Adequacy. As shown in the figure 1. This section reviews the literature on these criteria.

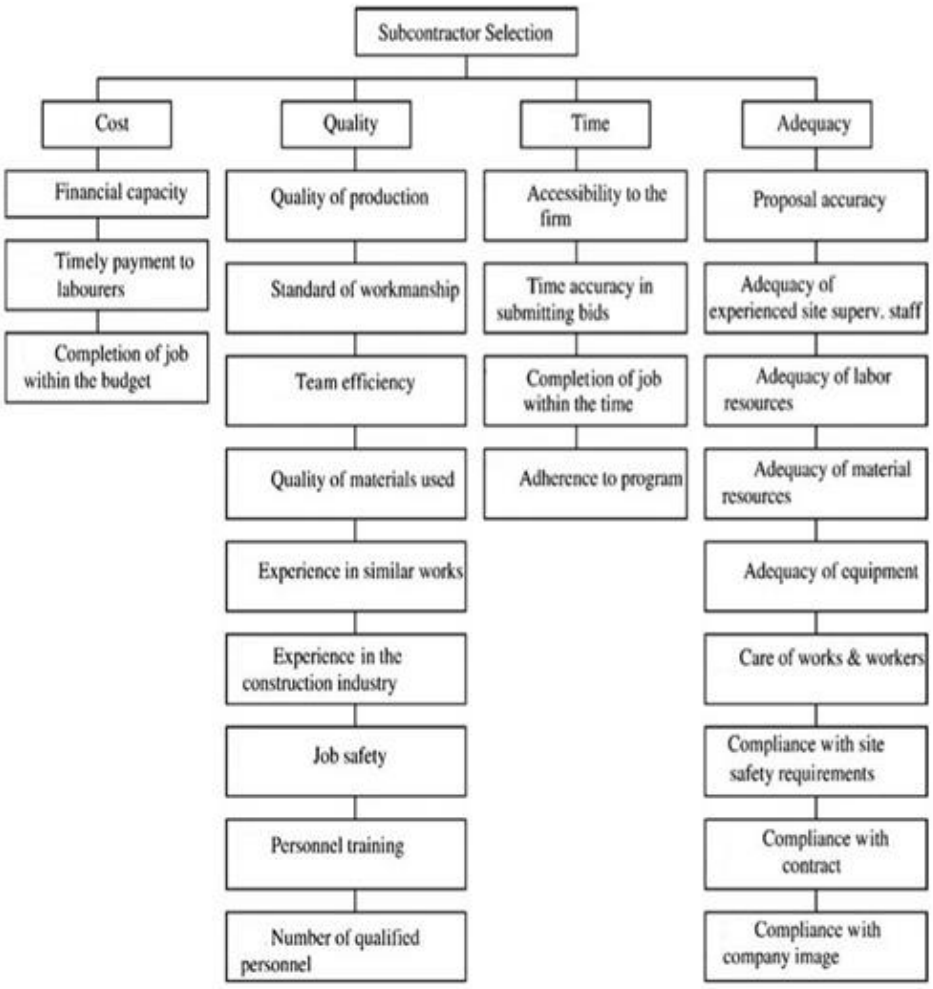


Figure 2.1 Subcontractor selection criteria

Source: Arslan et al., 2008

Cost

The cost According to the economic Theory of the Firm (Hartmann, Ling, & Tan, 2009), the contractors' objective is to maximize their profit. A corollary of this theory is that given a level of output, firms minimize costs. Firms that do not come close to maximizing their profits and minimizing their costs are not likely to survive.

Main contractors need to win tenders so that they have a chance to maintain the viability of their businesses (Dulaimi & Hong, 2002). Based on the contractors' need to minimize cost and maximize profit, they are likely to select subcontractor who submit the lowest price. Profit maximization is the closest approximation to the average behavior in the construction industry(Oforia, 1993). Indeed, tender price has been the dominating decision basis in subcontracting choices for decades and is still shown to be a significant criteria(Greenwood, 2001).

Quality

Besides having the technical knowledge to accomplish desired tasks, the provided work quality is a critical antecedent to the overall project performance (George Woon, 2000) and (Arditi et al., 2005b). Quality is the extent to which subcontractor actually deliver products or services that meet project requirements.

Admittedly, technical know-how can contribute to the quality of the final product, but there are other factors determining whether the final product delivered by the subcontractor meets project requirements (e.g. working environment, quality planning and control, and attitude of employees). Quality may comprise four aspects: technical quality, functional quality, workmanship quality, and architectural quality (Chan, 2000).

Technical quality is a measure of the quality of the building at the technical level, that is, the quality of materials, components, fittings, and finishes. Functional quality is the extent to which the building meets the objectives for which it was intended. Workmanship quality is a measure of the standard of workmanship in the completed building. Architectural quality is a measure of the quality of the building in architectural and aesthetic terms.

Quality is usually evaluated based on past experience with the subcontractor or on the basis of reputation based on opinions and experiences of other firms. Main contractors are more likely to award contracts to subcontractor that demonstrate superior technical and workmanship quality and show good site management and supervision ability (Dulaimi & Hong, 2002) to ensure good product quality. Admittedly, good past performance is not a guarantee for future performance. However, past behavior and/or past performance is the best predictor of future behavior and performance (Ling, Y. and Tan, 2001) based on the Consistency Principle. Studies have shown that past job performance is a valid predictor of future job performance (Hunter, John E.; Hunter, 1984).

Time

It is one the most important selection criteria for any subcontractor selection. As they should be accessible to the firm and should have time accuracy in submitting the bids .Also the completion of the given project should be done in within the time limit of the project .At any point of time during the process of construction the subcontractor should

adhere to the proper schedule of the project i.e. they should adhere to the project program.(Zou & Lim, 2006)

Adequacy

In the construction industry, there are underlying difficult relationships and lack of communication among various parties(Bryant, 1984) (Loosemore & Tan, 2000). Since subcontracted services have to be performed through relationships established between main contractors and subcontractor, cooperation or the extent to which subcontractor fulfill agreements and proactively solve and prevent problems is seen to be highly relevant for the operational efficiency of construction projects (Paul Humphreys, Jason Matthews, 2003). This includes individuals who exhibit courtesy and altruism, do not make complaints, are helpful, and cooperate with co-workers and customers (Podsakoff & MacKenzie, 1997). Main contractors will be more willing to select subcontractor that show a positive attitude, commitment, and quick response to their needs (Dulaimi & Hong, 2002). Like quality criteria, cooperation can be evaluated on the basis of the contractor's own experience with particular subcontractor, or on the basis of reputation in terms of opinions and experiences of other firms.

The following is a list of twenty-nine (29) potential criteria for subcontracting selection collated from literatures on the topic with particular reference to the work of (Hartmann et al., 2009) listed under the categories; Quality, Financial soundness, Technical Ability, Management Ability, Health and Safety, Reputation, and Others.

Table 2.1 Subcontractor selection Criteria

	Criteria	Remarks
	Quality	
1	Quality performance (e.g. ISO 9000 accreditation)	What's the standard of quality of the subcontractor? Do they have certain quality certifications?
	Financial soundness	
2	Financial stability.	Whether the subcontractor faces any financial problems that lead to financial instability
3	Tender price	It is the price offered by the subcontractor to win the tender (the lowest price wins)
4	Credit rating.	How the previous contractor rated the subcontractor?
5	Banking arrangements and bonding.	How fast and authenticate is their banking and financial system?
6	Financial status.	What's there financial status?
	Technical ability	
7	Experience.	Does the subcontractor have a good Reputation in his surrounding area? (high work quality, sufficient time management and reasonable cost rates)
8	Plant and equipment.	The subcontractor physical resources, including the equipment and tools
9	Personnel.	How technical their personnel are?
10	Ability	Education and skills of the subcontractor.
	Management capability	
11	Past performance and quality.	What's their past projects and quality of work?
12	Project management organization.	How reliable and skilled is their project management?
13	Performance history	How good is their performance?
14	Geographical location	Where are their headquarters located?
15	Physical size/growth	What is the size of the organization?
16	Experience of technical personnel.	How much experience is their top technical personnel have?
17	Management knowledge	What's the management knowledge of the personnel?
	Health and safety	
18	Safety.	Do they have safety rules and regulations?
19	Experience modification rating.	Is their organization rated?
20	OSHA Incident rate.	Do they have OSHA incident rate?
21	Management safety accountability	Do they take safety in accountability?

	Reputation	
22	Past failures.	Past failures projects of subcontractor
23	Length of time in business.	How many years has the subcontractor been working in the industry?
24	Past owner/contractor relationship.	How is the subcontractor' relationship with past contractors?
25	Scale of projects completed and in progress	How many projects does the subcontractor work on in parallel with a current project?
26	Amount of past business	How well did they do in past projects?
27	Industrial relations	The relationship between the client and the subcontractor who applied in the tender
28	Other relationships	Other relationships in market
29	Cultural similarity	Culture differences

2.4.6 FACTORS INVOLVED IN SUBCONTRACTOR PERFORMANCE

Subcontractor performance is as an important index used by general contractors to select optimal subcontractor. As the index reflects previous performance, it is presumed that a subcontractor historical performance can predict future performance. Subcontractor performance is affected by different expected and/or unexpected factors, such as management ability, worksite condition and subjective assessment (Shash, 1998). Thus, predicting subcontractor performance is a complex process with uncertainties that require judgments based on human expert knowledge and experience.

Subcontractor are generally categorized into four types based on services provided. These include: 1) labor, 2) labor and materials, 3) materials and 4) equipment, each with their particular characteristics. In practice, subcontractor performance is evaluated using two scores, namely a primary score and final score with various contributing factors.

Primary scores are evaluated by field superintendents. Final scores are assigned by general contractor management using primary score as one point of reference. Problems

occurring with this evaluation approach include: 1) generalization is difficult different factors for different types of subcontractor are difficult to generalize;2) primary and final scores are independently determined by human experts based on personal knowledge and experience; and 3) the relationship between primary and final scores is not well defined.

Subcontractor Assessment Factors

1 Construction technique

2 Duration control abilities

3 Cooperative managers

4. Material wastage

5 Services provided after work completion

6 Collaboration with other subcontractor

7 Safe working environments

8 Self-owned tools

9 Clean working environment

10 Effective management capabilities

11 Manager Personalities

12 financial conditions

2.5 CONCLUSION

Subcontractor' selection decisions are of prime importance to general contractors. These decisions are exercised by general contractors multiple times on every single project. Most general contractors identify quality, schedule control, and worker training as the key areas for subcontractor' productivity improvement, whereas they identify quality and business ethics as potential improvement areas for material vendors.

With the above given literature review it can concluded that there is significant need of looking into the criteria before handling the project to the subcontractor. In this study, the above stated criteria according to their importance in the construction industry. Thus literature review can be concluding by putting up some research question as follows:

1. What are the subcontractor selection criteria for construction projects in Saudi Arabia?
2. Which among these criteria are the most important for general contractors?
3. How these criteria influence the performance of the project?

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This section presents all the steps that were performed to achieve the objectives of this study. It includes all information relevant to the collection of the required data, where and how the data was obtained, and the method used for the analysis of the responses. The goal of this methodology was to develop and evaluate a list of relationship factors and determine the most important factors that affect the relationship between the subcontractor and the general contractor from the contractors' perspective.

3.2 SELECTION OF RESEARCH METHOD

Research strategy can be defined as the way in which the research objectives can be questioned (Mustapha & Naoum, 1998). Research is a thorough, systematic investigation or inquiry to validate old knowledge and generate new knowledge (Burns, 1989).

In any form of research, it will be required to either count things and/or talk to people. We can broadly classify research methods using this distinction. These two types of research method and their output data are classified as:

Quantitative - as the name suggests, is concerned with trying to quantify things; it asks questions such as 'how long', 'how many' or 'the degree to which'. Quantitative methods

look to quantify data and generalize results from a sample of the population of interest. They may look to measure the incidence of various views and opinions in a chosen sample for example or aggregate results(Stuart MacDonald & Nicola Headlam, 1999).

Qualitative – concerned with a quality of information, qualitative methods attempt to gain an understanding of the underlying reasons and motivations for actions and establish how people interpret their experiences and the world around them. Qualitative methods provide insights into the setting of a problem, generating ideas and/or hypotheses(Stuart MacDonald & Nicola Headlam, 1999).

	Quantitative	**Qualitative**
Aim	The aim is to count things in an attempt to explain what is observed.	The aim is a complete, detailed description of what is observed.
Purpose	Generalisability, prediction, causal explanations	Contextualisation, interpretation, understanding perspectives
Tools	Researcher uses tools, such as surveys, to collect numerical data.	Researcher is the data gathering instrument.
Data collection	Structured	Unstructured
Output	Data is in the form of numbers and statistics.	Data is in the form of words, pictures or objects.
Sample	Usually a large number of cases representing the population of interest. Randomly selected respondents	Usually a small number of non-representative cases. Respondents selected on their experience.
Objective/ Subjective	Objective – seeks precise measurement & analysis	Subjective - individuals' interpretation of events is important
Researcher role	Researcher tends to remain objectively separated from the subject matter.	Researcher tends to become subjectively immersed in the subject matter.
Analysis	Statistical	Interpretive

Figure 2.2 Quantitative Vs Qualitative key features

Source (Stuart MacDonald & Nicola Headlam, 1999)

Quantitative method is used as research method in this study as it is used mainly when data is structured unlike in quantitative method. The statistical analysis can be done in quantitative method whereas in qualitative method we can't put statistical formulas for analyzing.

3.3 DESCRIPTION OF THE QUANTITATIVE METHOD

Quantitative methods are research techniques that are used to gather quantitative data, data that can be sorted, classified, measured. Surveys are a popular method of collecting primary data. The broad area of survey research encompasses any measurement procedures that involve asking questions of respondents. They are a flexible tool, which can produce both qualitative and quantitative information depending on how they are structured and analyzed(Stuart MacDonald & Nicola Headlam, 1999). A questionnaire is also considered the best method to use in cases of non-accessibility to ''documented data''.

Questionnaire survey is one of the most popular and simplest methods in order to achieve the objectives of this study. Questionnaire is defines as a formal set of question or statement designed together the information from respondents that will accomplish the goals of the research project (Anang Hudaya Muhamad Amin Ahmad Izuddin Zainal Abidin, and Miziana Abdul Rahman, 2006).The questionnaire designed need to meet the objective and aim of the study. The design decisions depend on the purposes of the study, the nature of the problem, and the alternatives appropriate for its investigation (Isaac, Stephen, 1971). A design is a strategy for constructing the research structure using concise notation that summarize a complex design structure efficiently, to show all of the

major parts of the research project the background problems theoretical frameworks, hypothesis, research questions, methodology-work together to try to address the center research objective (Sale, Lohfeld, & Brazil, 2002).Three fundamental considered before design the question:

- What is the purpose of the survey?
- What kind of question the survey developed to answer?
- What sorts of results consider from the questionnaires?

Two type of question that used in the questionnaire survey, open-ended and close-ended. Open-ended question do not provide respond choice and sensitive to the respondents desire for expression. The close-ended sub divided to dichotomous and multiple choices question. The close-ended questions supply response choices and reduce in interpreter bias and easy to analysis. Dichotomous question are close-ended question that offer to response choices and suitable to understand the respondents demographic compassion (Anang Hudaya Muhamad Amin Ahmad Izuddin Zainal Abidin, and Miziana Abdul Rahman, 2006). This method was used closed ended questions with scaled question method.

3.4 METHOD OF DATA COLLECTION

This is a very important step as it explains the method of collecting the data which is required in order to achieve the objectives of the study. Method of data collection involves identification of the following:

3.4.1 KEY INFORMANT

It is very important to identify the key informant from which the data required for achieving the objectives can be acquired. Selection of the key informant is very significant as it determines the authenticity of the information acquired about a particular feature of the organization. The required data for this study was obtained from the top management of the contractor's organization who is responsible for subcontractor' selection for the projects.

3.4.2 TOOLS

The tool which was used to obtain the required data to achieve the objectives of the study was identified after thorough consideration as it will affect the quality of the response. A tool which clearly shows the objectives of the study, the data required the interest of the receiver and the importance of the informer should be used(Isaac, Stephen, 1971). In this study a close-ended questionnaire is used to collect the data. A close-ended questionnaire is used for its advantages as it is easy to ask and quick to answer, and does not require writing either by the respondents or interviewer.

Questionnaire design

A questionnaire accompanied with a covering letter was delivered to contracting companies in person. The letter indicated the objectives of the research and explained to the participants that the results of the questionnaire will be used to improve the subcontracting practices in construction industry.

The questionnaire is composed of four sections to accomplish the aim of this research, which are as follows:

The Contractors Organization profile: This section contains questions seeking information related to contractors profile such as the size, number of employees, number of projects completed etc.

The Respondents profile: This section contains questions seeking information related to the respondents profile such as educational level, job title, experience etc.

Subcontracting in the organization: This section contains questions seeking information related to subcontracting practices in the organization such as how long they are subcontracting the projects, percentage of the work subcontracted, kind of work subcontracted,etc.

Subcontractor' selection criteria: This section contains questions seeking information related to subcontractor selection criteria that the contractor believes to be suitable.

At the end of the last three sections an option was given to the respondent to add and rate any additional subcontracting selection criteria that he might think is significant.

Appendix A presents the developed questionnaire.

3.4.3 METHOD

The questionnaire that is illustrated in appendix A was taken to each of the contractors' in person to collect the required data to achieve the objective of the study.

3.5 POPULATION AND SAMPLING

A population consists of the total number of objects about which the study is concerned. In this study, the population is, mostly building contractor, the grade 1, 2 and 3 Construction contractors in the Eastern Province of Saudi Arabia as per classified by the ministry of municipality and rural affairs.

In this study, the size of the samples was determined using the following formula (Cochran 1977):

$$n = n°/(1 + n°/N)$$

$$n° = t^2 Pq/d^2$$

Where

n= sample size

$n° = first\ exrimate\ of\ the\ sample\ size$

N = Total Population = 168 (grade 1, 2, 3 building contractors in Eastern region)

t = value of the standard normal variant (if 95% confidence level, t=1.96)

P= the proportion of the characteristics being measured in the target population

(P = 0.5)

q = 1-P = 1- 0.5= 0.5

d = the precision = 0.15

Substituting the pre-defined variables in the formula, the sample size obtained is

n = 34 , for total population of N = 168.

It is usually the case in such a study that the response rate will not be high. In this study a response rate of 35% was predicted. 90 questionnaires were taken to the building contractors personally in the eastern region of Saudi Arabia. 35 answers were received from the building contractor.

3.6 SCORING SYSTEM

The initial section of the questionnaire doesn't really require any sort of scoring system. But for section II we have Likert scale scoring. Likert scales usually have five potential choices (strongly agree, agree, neutral, disagree, strongly disagree) but sometimes go up to ten or more. The final average score represents overall level of accomplishment or attitude toward the subject matter. Named after its inventor, the US organizational-behavior psychologist Dr. Rensis Likert (1903-1981).

3.7 DATA ANALYSIS

Data obtained from the questionnaire was analyzed and used to identify the significant subcontractor' selection criteria and that are considered important by the construction contractors in the Eastern Province of Saudi Arabia.

Statistical method such as SPSS software was used to interpret the results. SPSS (Statistical Package for the Social Sciences) is a software package used for statistical analysis. Bivariate Correlation was used to get the relationship between the performance and the other criteria. SPSS is among the most widely used program for statistical analysis in Social science. This is a data analysis package for quantitative research. It is particularly useful for the analysis of survey data as it covers a broad range of statistical procedures. There are other packages available such as SAS, Stata

or Minitab however all are expensive to purchase, especially if only to be used for a one off survey(Stuart MacDonald & Nicola Headlam, 1999). The analyzed data is presented in tabulated format and Figures. Graphical representations have a tendency to make the comparisons clearer and thus were used for showing the important criteria. By carefully studying the results of the survey, a better understanding will be gained of the current situation of the subcontractor' selection in construction industry. This will also help in recommending the next approach for further studies on the subject.

CHAPTER 4

RESULTS & ANALYSIS

This chapter presents the data analysis of the outcomes from the questionnaire survey so that the subcontractor' selection criteria currently used by contractors in the Eastern Province of Saudi Arabia can be understood. Mainly, the respondents profile, contractors' organizations, quality, performance and their relation are discussed in detail in the following sections. Statistical analysis is a mathematical method of interrogating data. This is done by looking for relationships between different sets of data. Statistical analysis can be complex, and this following section aims to explain some of the basic considerations, to an audience without an assumed mathematical background. Moreover, the results would go through an analysis such that suggestions or recommendations can be put forward to overcome the problems faced in the current practice of subcontractor' selection.

4.1 CHARACTERISTICS OF THE PARTICIPANT

The necessary information was acquired using a questionnaire. The questionnaire was sent to the population of construction contractors who are major in building in the Eastern Province of Saudi Arabia. The questionnaire was taken to contractors' office in person to increase the response rate. The responses were collected over a period of 4 months. Initially the response rate was very slow and later on gained push as personal meetings

with project managers and construction executives were done to get their responses. A total response rate of nearly 38% was achieved in the due course of data collection.

4.1.1 CONTRACTORS PROFILE

Contractors profile such as the size, number of employees, number of projects completed etc., are used to describe the participating organizations.

- More than 80 % of the participating organization is in the market of construction for more than 15 years as shown below in the Table 4.1. It seems that most of these participated contractors are with good experience and capabilities in the construction business. This indicates that a major ratio of the contractors have been established for a long time and have sufficient experience and knowledge in the Saudi construction industry.

Table 4.1 Organization age

Years	less than 5	5-10	10-15	15-20	20 or more	Total
Frequency	1	2	4	16	12	35
Percent (%)	2.9	5.7	11.4	45.7	34.3	100.0

- Most of the participated contractors (nearly 62.8%) employed more than 1000 personnel in their organization as shown below in Table 4.2. This indicates that they are very well equipped with large man power and are capable of carrying large projects. This is expected as the study target population is large contractors.

Table 4.2 Number of employees in organization

Number of Employee	50-100	100-500	500-1000	1000-1500	1500 or more	Total
Frequency	1	8	4	18	4	35
Percent (%)	2.9	22.9	11.4	51.4	11.4	100.0

- The majority of the contractors undertake only private projects i.e. nearly 72% of the total participated organizations. It can also be seen that nearly 23% of the organization said that they provide their services to both government and private clients and are not inclined only to one sector as shown below in Table 4.3. This mix of experience adds great value to the provided information which is related to subcontractor' selection.

Table 4.3 Clients distribution

Organization Clients	private	government	both	Total
Frequency	25	2	8	35
Percent (%)	71.4	5.7	22.9	100.0

- The participating contractors are varying with respect to the number of projects executed in the last 5 years regardless of the client they have with overall 48.6% of the participating contractors undertaking 20 to less than 30 projects and 37.1% undertaking 30 or more projects as shown below in Table 4.4. This is the sign that most of the participating contractors were having good experience in building construction projects.

Table 4.4 Projects completed in last 5 years

Number of projects	less than 5	5-15	15-20	20-30	30 or more	Total
Frequency	1	1	3	17	13	35
Percent (%)	2.9	2.9	8.6	48.6	37.1	100.0

- As the study is restricted to only building contractors, they comprise majority (88.5%) of the participants. The industrial contractors were only 5.7% of the participants hence their information was also used as part of the study. The results indicated that all the participating contractors are carrying out different types of projects regardless of the client such as Industrial, Residential, Public Utilities and Commercial and are not limiting themselves to a particular type of construction as shown below in Table 4.5. The contractors who do residential type of project makes the 72% of the participated contractors as research study mainly concentrated on residential construction contractors.

Table 4.5 Type of construction performed

Type of construction	Industrial	Residential	Public Utilities	Commercial	Total
Frequency	2	25	2	6	35
Percent (%)	5.7	71.4	5.7	17.1	100.0

4.1.2 THE RESPONDENTS PROFILE

- Respondents profile such as the educational level, job title, experience etc., are discussed in detail below to determine the knowledge and experience of respondents thus ensuring the credibility of the results obtained.

- Most of the questionnaire was completed by the top management of the organizations such as Business Development Manager, Projects Manager, Quality Management Representative, Division Manager, General Manager, Engineers and etc. This shows that the answers that are obtained regarding the subcontractor selection criteria from the contractor are given by the personnel who are aware of the important decisions and practices that their organization undertakes thus ensuring that the required data on our study was obtained from reliable and well experienced experts. The majority (94.3%) of these experts have at least a bachelor degree. This shows that the respondents have good academic knowledge and have understood the question properly.

- The majority (62.85%) of the respondents are working with their present organization for more than 11 years as shown below in Figure 4.1. This shows that most of the respondents are working in their respective organization for sufficient time in order to be aware of the methods, procedures and practices their organization undertakes regarding subcontractor selection methods.

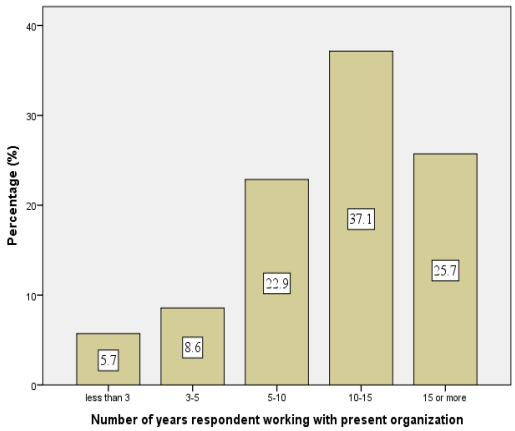


Figure 4.1 Experience in present organization

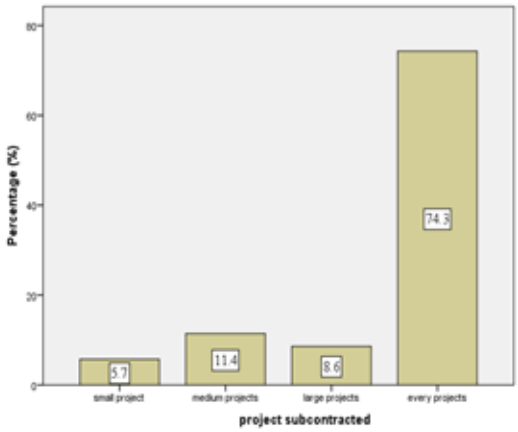


Figure 4.2 Total experience in construction industry

- Majority (71.4%) of the respondents are working in the construction industry for more than 15 years as shown in Figure 4.2. This shows that the respondents had sufficient knowledge and experience of the questions that are asked in the questionnaire and have answered the questions accurately. Thus, ensuring the credibility of the results that are obtained from this study.

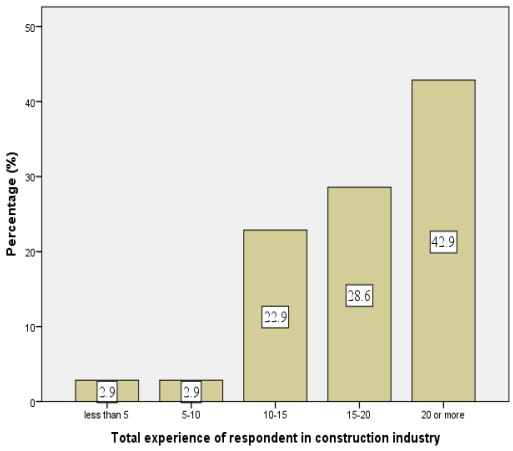


Figure 4.3 Size of project subcontracted

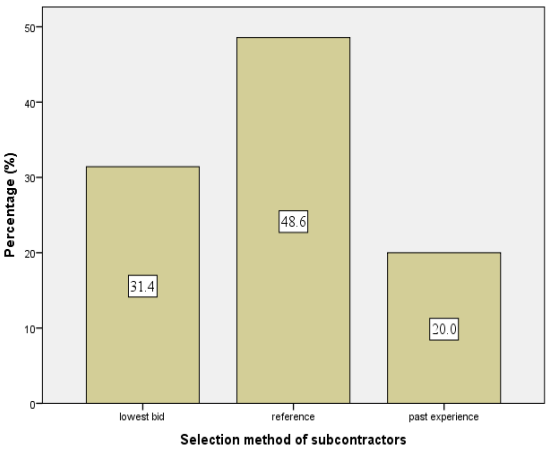
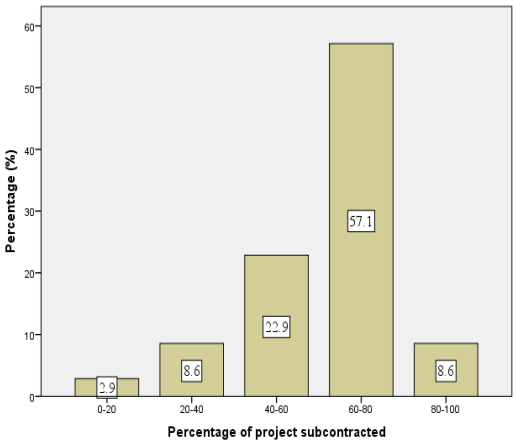


Figure 4.4 subcontractor selection method

- If subcontracting is considered by point of view of size of project then majority (74.3%) of the respondents' organization give out subcontracting work for every project they get from the clients. Whereas nearly 20% of the respondents from the Figure 4.3 say that their organization subcontracts work only for medium and large projects which shows that subcontractor are the important part of any project in construction industry.
- The majority (48.57%) of the respondents' organization give out subcontracting work to the firms which have a better reference as shown in figure 4.4. Also nearly 31.4% of the respondents give the subcontracting work to the lowest bidding organization.

This shows that contractors believe that reference is the good sign for any subcontractor to fetch more projects. Tender price (bidding) is the price offered by the subcontractor to win the tender. The tender price should not be the main criteria based on which the selection process occurs. However, in real life it is still an important factor in the sub-contractor's selection process. This was highly supported by the study from (Marzouk, El Kherbawy, & Khalifa, 2013) which states tender price as the decision making process for most of the projects. But from our results it's clear that reference is the most preferred method of subcontracting the projects in Saudi Arabia.

- The majority (65.7%) of the contractors gives more than 60% of the project to subcontractors if percentage of project is taken into account, which shows that subcontractor are the internal part of any construction projects and their selection is of prime importance to the success of the project. Also it can be seen from the Figure 4.6 that nearly 23% of the contractors give out about 40 to 60 % of the project to the subcontractor.



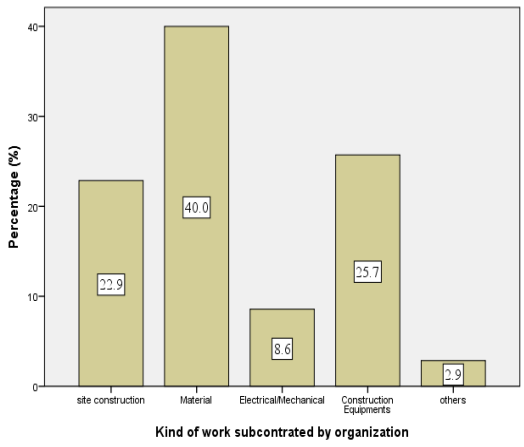


Figure 4.5 Percentage of project subcontracted **Figure 4.6 Type of work subcontracted**

- The results indicates that almost 40% of the participating contractors gives subcontract to construction material which can be interpret that subcontractor are the major suppliers of the construction materials in construction . It can be seen in the Figure 4.7 that nearly 26% of the construction equipment's are subcontracted i.e. on rent or lease.

4.2 SUBCONTRACTOR SELECTION CRITERIA

Subcontracting selection criteria in the organization related to quality, financial, performance, technical capabilities, etc., are discussed below to understand the current status of subcontractor' selection criteria in the participating contractors' organization.

As we have non-parametric data, mean and median are used to analyze the surveyed data. ***Mean*** - The mean is more commonly called the average, however this is incorrect if "mean" is taken in the specific sense of "arithmetic mean" as there are different types of averages: the mean, median, and mode. ***Median*** - The median is the middle of a distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than the mean and this makes it a better measure than the mean for highly skewed distributions.

- There are 12 such criteria whose median are equal to 4 and are considered to be the most important criteria by general contractors for selection of subcontractor. The list is presented in the Table 4.6. There were 15 such criteria whose median is 3 among the 28 subcontractor selection criteria. In Table 4.6, the criteria have been arranged

based on the highest median value. If different criteria has same median then criteria with highest mean was kept at top to show its importance.

Table 4.6 Subcontractor Selection criteria

Criteria	Mean	Median
Experience	4.2286	4.0000
Plant and equipment	4.1429	4.0000
Tender price	3.9714	4.0000
Safety	3.9143	4.0000
Quality	3.8286	4.0000
Past performance	3.8000	4.0000
Financial stability	3.7714	4.0000
Financial status	3.7714	4.0000
Banking arrangements and bonding's	3.6857	4.0000
OSHA incident rate	3.6857	4.0000
Length of time in business	3.6571	4.0000
Project management organization	3.6000	4.0000
personnel	3.6857	3.0000
Experience of technical personnel	3.5714	3.0000
Ability	3.5429	3.0000
Credit rating	3.5143	3.0000
Past failures	3.4571	3.0000
Size and growth	3.4000	3.0000
Scale of project completed	3.3429	3.0000
Experience modification rating	3.3143	3.0000
Management safety Accountability	3.3143	3.0000
Past owner /contractor relationships	3.3143	3.0000
Performance history	3.2571	3.0000
Management knowledge	3.2286	3.0000
Amount of past business	3.2286	3.0000
Geographical location	3.1143	3.0000
Industrial relation	2.9714	3.0000
Cultural similarity	2.5714	2.0000

- Technical ability quality and tender price are the most likely the important criteria for subcontractor selection. Also it can be seen from the Table 4.6 that financial stability and financial status of the organization are considered to be the second most important criteria for their selection.
- Majority of participating general contractors said that technical experience and availability of material plant and construction equipment's are the most important criteria. From the Table 4.6, it can be seen that technical experience and plant & equipment's have the highest median and mean value. This shows that the contractors wants to know prior to subcontract the work if the subcontractor have enough technical experience and construction equipment's.
- Safety and OSHA incident rate is considered to be the important criteria in subcontractor selection process. Safety of personnel, equipment and construction site is important as it create sate environment for working. In the Table 4.6, both safety and OSHA has median value of 4 but it can notice that management safety accountability with median value of 3 is considered to be least important.
- The participating contractors are having varying opinions in regard to the management capabilities of the subcontractors. Past performance and project management are considered to be the utmost important criteria with median of 4. Also, the personnel in organization does make value for the project, hence it's too considered to be the important criteria as it has median of 3 but a healthy mean value .
- The length of time in business in construction industry is considered to be the most important criteria for subcontractor selection. From Table 4.6, it can be seen that the

past failures of the organization gives bad impact on part at time of selecting, the general contractors considered it to be medium importance as it has a mean value of nearly 3.5.

- The cultural similarity has only median value of 2 which says that the general contractors want the other region/country subcontractors to bid in the tender to be considered as important as other local subcontractors.

4.3 CORRELATION OF SELECTION CRITERIA WITH PERFORMANCE ISSUES

Subcontractor performance is as an important index used by general contractors to select optimal subcontractor. As the index reflects previous performance, it is presumed that a subcontractor historical performance can predict future performance. Subcontractor performance is affected by different expected and/or unexpected factors, such as management ability, worksite condition and subjective assessment (Shash, 1998). Thus, predicting subcontractor performance is a complex process with uncertainties that require judgments based on human expert knowledge and experience.

Correlation is a widely used term in statistics. Correlation generally describes the effect that two or more phenomena occur together and therefore they are linked. Many academic questions and theories investigate these relationships. A correlation expresses the strength of linkage or co-occurrence between to variables in a single value between -1 and +1. This value that measures the strength of linkage is called correlation coefficient, which is represented typically as the letter r.

Bivariate Correlation in SPSS: Spearman rank correlation is a non-parametric test that is used to measure the degree of association between two variables. It was developed by Spearman, thus it is called the Spearman rank correlation. Spearman rank correlation test does not assume any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal.

- The bivariate Correlation is commonly used to measure the following:
    - Correlations among pairs of variables
    - Correlations within and between sets of variables
- The bivariate Pearson correlation indicates the following:
    - Whether a statistically significant linear relationship exists between two continuous variables
    - The strength of a linear relationship (i.e., how close the relationship is to being a perfectly straight line)
    - The direction of a linear relationship (increasing or decreasing)
- ***Spearman correlation*** - Spearman's Rank Correlation is a technique used to test the direction and strength of the relationship between two variables. In other words, it's a device to show whether any one set of numbers has an effect on another set of numbers.
- ***Mann-Whitney test*** - The Mann-Whitney test is a non-parametric test for assessing whether two samples of observations come from the same distribution, testing the null hypothesis that the probability of an observation from one population exceeds the probability of an observation in a second population.

- ***Kruskal-Wallis test*** - A non-parametric method for testing equality of population medians among groups, using a one-way analysis of variance by ranks.

4.3.1 BIVARIATE CORRELATION ANALYSIS

Bivariate correlation analysis is done to know the significance of the criteria based on the performance issues during the project. With performance issues coded as P1, P2 … so on till P15 and criteria coded as C1, C2… so on till C28 (see appendix for codes) are analyzed using the SPSS software for bivariate correlation, the results are as shown in Table 4.11.

- Schedule performance (P1) in correlation analysis gives a positive correlation (i.e. significant value of less than 0.05) with geographic location (C4) and safety (C18). Although the significant value of correlation between P1 and C5 is slightly higher than 0.05, it can still be consider significant. It can be said that when contractors consider Banking Arrangement and Bonds (C5), Geographic Location (C14) and Safety (C18) as important criteria, they more like to consider Schedule Performance (P1) as important performance issue during the project execution.
- Quality performance (P2) has significant positive correlation (i.e. significant value of less than 0.05) with selection criteria of personnel (C9) and the tender price (C3) of the project. This shows that the general contractor when take tender price (C3) and personnel (C9) as important criteria, they more likely to consider quality performance (P2) as important performance issue during the project execution.

- Ability to control the cost (P3) is one of the most important performance issue for any project and has significant positive correlation (i.e. significant value of less than 0.05) with selection criteria like Project management (C12), OSHA incident rate (C20), Length of time in business (C23) and Past relationships (C24). This shows that when general contractors consider selection criteria like C12, C20, C23 & C24 as important, they more likely to consider P3 as important performance issue during the project execution.
- Subcontractor poor management ability (P4) has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria project management organization (C12) and management knowledge (C17) along with industrial relation (C27). This shows that when general contractors consider selection criteria like C12, & C27 as important, they more likely to consider P4 as important performance issue during the project execution.
- Energy saving material and installation (P5), has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria financial status (C6), Geographical location (C14), experienced technical personnel (C16) and industrial relation (C27). This shows that when general contractors consider selection criteria like C6, C14, C16, & C27 as important, they more likely to consider P5 as important performance issue during the project execution.
- Cost overrun (P6) is the cost of the project exceeds the expected value of the project during the construction stage. It has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria performance history (C13), geographic location (C14), length of time in business (C23), scale of projects completed (C25),

amount of past business (C26), industrial relation (C27) and cultural similarity (C28). This shows that cost controlling is very important during the execution of the project. This also shows that when general contractors consider selection criteria like C13, C14, C23, C25, C26, C27 & C28 as important, they more likely to consider P6 as important performance issue during the project execution.

- Poor competency of laborers (P7) is the laborers incompetency especially in time management and work quality. It has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria personnel (C9). This shows that when general contractors consider selection criteria like C9 as important, they more likely to consider P7 as important performance issue during the project execution.
- Jobsite cleanliness during project and upon leaving jobsite (P8) is about keeping the working site easy to accessible and maintained cleanliness around the working area. It has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria plant and equipment (C8), project management organization (C12), performance history (C13), geographical location (C14) and past owner/contractor relationship (C24). This shows that when general contractors consider selection criteria like C8, C12, C13, C14 & C24 as important, they more likely to consider P8 as important performance issue during the project execution.
- Safety conscious on the job site (P9) is the amount of safety like safety shoes, hard hats, jackets and other safety precautions provided by the subcontractor to its personnel while working on the site. It has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria Experience (C7). This

shows that when general contractors consider selection criteria like C7 as important, they more likely to consider P9 as important performance issue during the project execution.

- Not buying insurance for major equipment's and employee (P10) has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria past failure (C22. This shows that when general contractors consider selection criteria like C22 as important, they more likely to consider P10 as important performance issue during the project execution.
- Flexibility and cooperation when resolving delays (P14) has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria tender price (C3), plant and equipment's (C8), Ability (C10) and past performance (C11). This shows that when general contractors consider selection criteria like C3, C8, C10, & C11 as important, they more likely to consider P14 as important performance issue during the project execution.
- Knowledge of construction regulations (P15) is the awareness of subcontractor on the current construction laws and regulation of the region. It has the significant positive correlation (i.e. significant value of less than 0.05) with selection criteria Banking arrangements and bonds (C5) and past failure (C22). This shows that when general contractors consider selection criteria like C5, & C22 as important, they more likely to consider P15 as important performance issue during the project execution.

Table 4.7 Correlations between performance & criteria

Spearman's rho	P vs C		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
	C1	Correlation	-.078	.110	.097	.158	-.015	.269	-.080	-.058	-.114	.090	.099	-.015	.239	.237	.050
		Significance	.658	.531	.579	.363	.933	.118	.648	.739	.515	.609	.573	.933	.166	.170	.776
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C2	Correlation	.254	.085	.322	-.070	-.051	-.098	.218	.291	.189	.091	.230	-.047	.234	.076	.211
		Significance	.141	.628	.059	.690	.773	.575	.208	.090	.276	.603	.184	.787	.176	.666	.224
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C3	Correlation	.200	.522	.129	.142	.142	.222	.072	-.114	.002	-.056	.158	-.166	.404	.355	.312
		Significance	.250	**.001**	.460	.416	.414	.200	.681	.516	.991	.751	.365	.341	**.016**	**.036**	.068
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C4	Correlation	-.015	-.229	.124	-.151	.043	-.084	.324	.232	.264	.295	-.148	.212	-.225	-.211	.009
		Significance	.931	.186	.477	.386	.807	.630	.058	.181	.125	.085	.396	.222	.195	.223	.959
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C5	Correlation	.323	.168	.227	-.137	.143	-.207	.164	-.046	-.001	.039	-.207	.063	-.072	-.055	.479
		Significance	.058	.336	.189	.431	.414	.232	.347	.791	.996	.826	.233	.721	.681	.754	**.004**
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C6	Correlation	.083	.048	.209	-.090	.356	-.049	.256	.277	.284	-.034	-.046	.214	.205	-.133	-.082
		Significance	.634	.783	.228	.606	**.036**	.779	.138	.107	.098	.847	.792	.217	.237	.447	.640
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C7	Correlation	.061	.072	.040	-.028	-.141	.242	.150	.164	.442	-.169	.259	-.221	.237	-.029	-.188
		Significance	.727	.681	.820	.873	.420	.161	.391	.346	**.008**	.332	.134	.202	.171	.869	.280
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C8	Correlation	-.022	-.120	.001	.218	.155	.149	.317	.563	.254	.184	.232	-.028	.132	-.460	-.034
		Significance	.899	.494	.997	.208	.373	.392	.063	**.000**	.141	.289	.180	.873	.449	**.005**	.844
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C9	Correlation	-.020	-.552	-.209	.002	.029	.097	.395	.382	.272	.199	.048	.183	.060	-.215	-.027
		Significance	.908	**.001**	.229	.993	.869	.578	**.019**	**.024**	.115	.251	.784	.293	.731	.214	.877
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	C10	Correlation	.069	-.034	-.014	.012	-.025	.035	.051	.287	.095	.121	.122	.200	-.266	-.371	.017
		Significance	.694	.848	.938	.943	.887	.844	.770	.095	.589	.489	.485	.250	.122	**.028**	.922
		N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

Table 4.8 Correlations between performance & criteria (cont.)

Spearman's rho	P vs C		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
	C11	Correlation	-.088	-.069	-.050	.051	-.060	.009	-.031	.214	.143	.304	.018	.269	.078	.328	.170
		Significance	.614	.692	.774	.772	.733	.959	.858	.217	.412	.075	.917	.119	.657	**.055**	.329
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C12	Correlation	.257	.281	.367	.383	.056	.134	.048	.393	.139	.069	.009	.241	.141	-.007	-.011
		Significance	.136	.102	**.030**	**.023**	.749	.444	.782	**.019**	.427	.696	.961	.163	.418	.967	.950
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C13	Correlation	.279	.174	-.148	.282	.201	.413	.143	.413	.062	-.087	.027	.161	-.018	.186	-.104
		Significance	.105	.317	.397	.101	.247	**.014**	.414	**.014**	.723	.618	.877	.356	.916	.284	.552
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C14	Correlation	.418	.045	.224	.061	.461	.455	-.112	.368	.120	-.100	.178	-.146	.288	-.098	.208
		Significance	**.012**	.797	.196	.727	**.005**	**.006**	.522	**.030**	.491	.569	.305	.404	.094	.576	.231
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C15	Correlation	.273	.002	.021	-.016	-.078	-.013	-.055	.092	.082	.083	.148	-.018	-.108	-.033	.155
		Significance	.113	.989	.906	.928	.657	.941	.752	.600	.639	.635	.395	.919	.536	.850	.374
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C16	Correlation	.255	.057	-.025	-.133	.399	.080	-.056	.032	.083	.121	.276	-.023	-.080	-.060	.028
		Significance	.139	.747	.885	.445	**.017**	.646	.749	.853	.636	.490	.108	.896	.649	.732	.872
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C17	Correlation	.076	-.244	.286	.403	.170	.397	-.172	.661	.021	.202	.198	.214	.191	-.014	-.025
		Significance	.665	.157	.095	**.016**	.328	**.018**	.323	**.000**	.903	.245	.255	.218	.273	.938	.886
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C18	Correlation	.331	.339	-.079	.105	.095	-.006	.257	-.153	.203	-.312	.125	-.135	.086	.131	.104
		Significance	**.052**	.046	.654	.547	.586	.973	.137	.379	.241	.068	.474	.440	.623	.454	.553
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C19	Correlation	.000	-.090	-.010	.075	-.035	.080	-.041	.137	.029	-.061	.301	-.094	.274	-.114	.004
		Significance	.998	.606	.956	.670	.841	.649	.816	.433	.870	.730	.079	.591	.111	.514	.981
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C20	Correlation	-.005	.200	.405	.213	.069	.020	-.025	-.017	-.127	-.162	-.005	.029	-.039	.097	-.084
		Significance	.979	.249	**.016**	.220	.693	.909	.886	.925	.467	.353	.976	.870	.825	.579	.632
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000

Table 4.9 Correlations between performance & criteria (cont.)

Spearman's rho	P vs C		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
	C21	Correlation	.185	-.051	.151	.198	.161	.075	-.016	.007	-.071	.077	.075	.017	.061	.000	.285
		Significance	.287	.773	.386	.255	.357	.667	.925	.967	.687	.658	.668	.925	.728	.999	.097
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C22	Correlation	.022	-.242	-.097	-.151	-.057	-.009	-.039	.027	.230	.432	-.254	.302	-.255	-.039	-.474
		Significance	.902	.161	.579	.387	.744	.959	.823	.876	.183	**.009**	.141	.078	.139	.826	**.004**
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C23	Correlation	.165	.112	.404	.072	.226	.473	.040	.093	-.074	-.068	.084	.092	.135	-.204	.088
		Significance	.345	.520	**.016**	.681	.191	**.004**	.821	.593	.672	.699	.630	.598	.441	.240	.616
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C24	Correlation	.144	.247	.388	.028	.286	.219	-.182	.476	.008	.150	-.070	.252	-.021	.086	-.081
		Significance	.409	.153	**.021**	.875	.095	.207	.295	**.004**	.962	.389	.691	.144	.907	.625	.643
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C25	Correlation	.128	.050	.170	-.114	-.014	.365	.040	-.034	.031	-.006	-.118	.113	.046	.286	.255
		Significance	.464	.774	.329	.514	.934	**.031**	.818	.847	.860	.974	.500	.520	.795	.096	.140
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C26	Correlation	.299	.443	.273	.257	.139	.359	.125	.208	-.050	-.257	.040	-.018	.171	.020	.179
		Significance	.081	**.008**	.113	.137	.426	**.034**	.473	.231	.776	.135	.818	.918	.325	.911	.302
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C27	Correlation	.314	.274	.079	.368	.362	.603	.054	.309	.052	-.158	-.006	.159	.125	.050	-.081
		Significance	.066	.111	.652	**.029**	**.033**	**.000**	.756	.071	.765	.365	.971	.362	.475	.774	.643
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000
	C28	Correlation	.262	.117	.165	-.033	.155	.470	-.275	.303	.179	.143	-.122	.138	-.138	.148	-.136
		Significance	.128	.501	.343	.852	.373	**.004**	.110	.077	.303	.411	.485	.428	.431	.395	.438
		N	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000

- Of all selection criteria, there are six criteria that correlated with 3 or more performance issues. They are: C3, C9, C12, C14, C17 and C27. It can be interpreted that those criteria are important selection criteria.

4.4 NON–PARAMETRIC TEST ANALYSIS

Mann-Whitney test - The Mann-Whitney test is a non-parametric test for assessing whether two samples of observations come from the same distribution, testing the null hypothesis that the probability of an observation from one population exceeds the probability of an observation in a second population.

In our analysis, Mann-Whitney test is done between performance issue during the project and level of project subcontracted by the general contractors and also percentage of project subcontracted.

- The Table 4.10 provides the actual test statistics for the Mann-Whitney test. There are many variations on the Mann-Whitney test; in fact, Mann, Whitney and Wilcoxon all came up with statistically comparable techniques for analyzing ranked data. The important part of the table is the significance value of the test (look at the exact significance and halve its value to obtain the one-tailed significance if you have made a directional prediction)(Field, 2000). In Mann-Whitney analysis, we can see that no performance issue is having the significance value of less than 0.05 when test against size of project subcontracted. This shows that size of the project doesn't affect the concern of the main contractor on the performance issues during the project selection.

Table 4.10 Mann-Whitney analysis between performance & size of project subcontracted

Performance Issues	Mann-Whitney	Significance
Importance of the schedule performance	94.500	.385
Importance of the quality performance	91.000	.322
Ability to control the costs	98.000	.459
Sub-contractor's poor management ability	106.000	.716
Energy saving materials and installations	79.000	.116
Cost overruns	80.500	.163
Poor competency of laborers	80.500	.153
Jobsite cleanliness during projects and upon leaving jobsites	103.500	.587
Safety consciousness on the job site	90.000	.287
Not buying insurance for major equipment and employees	96.000	.402
Suppliers incompetency to deliver materials on time	94.000	.389
Failure to comply with the quality specifications	113.000	.874
Lack of readily available utilities on site	97.500	.468
Flexibility and cooperation when resolving delays	103.000	.565
Knowledge of construction regulations	106.000	.694

- Mann-Whitney test analysis results between performance issues and percentage of the project subcontracted are displayed in the Table 4.11. The ability to control the cost is the only performance issues which have the significance value of 0.66 which is nearest to 0.05. However, the performance issue Energy saving materials and installations can also be considered as significance as it also having slightly higher significance value near to 0.05.

Table 4.11 Mann-Whitney analysis of performance issue & percentage of project subcontracted

Performance Issue	Mann-Whitney	Significance
Importance of the schedule performance	127.000	.706
Importance of the quality performance	130.000	.847
Ability to control the costs	88.500	**.066**
Sub-contractor's poor management ability	115.000	.430
Energy saving materials and installations	93.000	.093
Cost overruns	129.500	.795
Poor competency of laborers	124.500	.675
Jobsite cleanliness during projects and upon leaving jobsites	100.000	.135
Safety consciousness on the job site	127.000	.701
Not buying insurance for major equipment and employees	131.000	.841
Suppliers incompetency to deliver materials on time	122.000	.586
Failure to comply with the quality specifications	119.000	.466
Lack of readily available utilities on site	112.000	.352
Flexibility and cooperation when resolving delays	129.000	.733
Knowledge of construction regulations	112.500	.349

- The Mann-Whitney test was done on performance and percentage of project subcontracted. The performance issue during the project was taken as the test variable and percentage of project subcontracted was grouping variable. In grouping variable, percentage from 0-60% was given as group 1 and from 60-100% as group 2. Then they are tested for mean ranks and sum of the rank to get the higher rank of performance issue that is affected by the percentage of project subcontracted. The Table 4.12 shows the results of the Mann-Whitney test. The mean rank for ability to control cost of the group that subcontracted the work 0-60% is higher than those who subcontracted the work >60%. It can be interpreted that when contractors are concern

about the ability of subcontractors to control the cost, they more likely to subcontract less percentage of project work. The mean rank for performance issue 'Energy saving material and their installation' of the group that subcontracted the work 0-60% is higher than those who subcontracted the work >60%. It can be interpreted that when contractors are concern about installing the energy the saving materials, they more likely to subcontract less percentage of project work.

Table 4.12 Mann-Whitney test rank between performance issue & Percentage of project subcontracted

Performance Issues	Percentage of project subcontracted	N	Mean Rank	Sum of Ranks
Importance of the schedule performance	0-60	12	18.92	227.00
	60-100	23	17.52	403.00
	Total	35		
Importance of the quality performance	0-60	12	18.67	224.00
	60-100	23	17.65	406.00
	Total	35		
Ability to control the costs	0-60	12	22.13	265.50
	60-100	23	15.85	364.50
	Total	35		
Sub-contractor's poor management ability	0-60	12	19.92	239.00
	60-100	23	17.00	391.00
	Total	35		
Energy saving materials and installations	0-60	12	21.75	261.00
	60-100	23	16.04	369.00
	Total	35		
Cost overruns	0-60	12	18.71	224.50
	60-100	23	17.63	405.50
	Total	35		
Poor competency of laborers	0-60	12	16.88	202.50
	60-100	23	18.59	427.50
	Total	35		

Jobsite cleanliness during projects and upon leaving jobsites	0-60	12	21.17	254.00
	60-100	23	16.35	376.00
	Total	35		
Safety consciousness on the job site	0-60	12	18.92	227.00
	60-100	23	17.52	403.00
	Total	35		
Not buying insurance for major equipment and employees	0-60	12	18.58	223.00
	60-100	23	17.70	407.00
	Total	35		
Suppliers incompetency to deliver materials on time	0-60	12	19.33	232.00
	60-100	23	17.30	398.00
	Total	35		
Failure to comply with the quality specifications	0-60	12	16.42	197.00
	60-100	23	18.83	433.00
	Total	35		
Lack of readily available utilities on site	0-60	12	20.17	242.00
	60-100	23	16.87	388.00
	Total	35		
Flexibility and cooperation when resolving delays	0-60	12	17.25	207.00
	60-100	23	18.39	423.00
	Total	35		
Knowledge of construction regulations	0-60	12	20.13	241.50
	60-100	23	16.89	388.50
	Total	35		

- ***Kruskal-Wallis test*** - A non-parametric method for testing equality of population medians among groups, using a one-way analysis of variance by ranks. Unlike Mann-Whitney test, which gives both mean rank and sum of the rank, this test gives only mean rank for the test analysis and is performed when we have three or more conditions to compare.

- The descriptive results for Kruskal-Wallis test analysis gives the chi-square, degree of freedom and significance value of the performance issues. The Table 4.13 provides

the actual test statistics for the Kruskal-Wallis test. The performance issues like importance of quality, poor management ability, safety and failure to comply with quality specifications are the issues which have the statistical significance value (i.e. significance value less than 0.05). The selection method makes a difference to how the contractor and subcontractor are related to each other in terms of business and market reputation. To avoid this quality and safety performance issues most of the contractors goes with the reference type of selection method so that they have control over the subcontractor and they should comply with the quality regulations.

Table 4.13 Kruskal-Wallis test analysis of performance issue & selection method of subcontractor

Performance Issues	Chi-Square	Significance
Importance of the schedule performance	3.020	.085
Importance of the quality performance	5.045	**.024**
Ability to control the costs	1.178	.296
Sub-contractor's poor management ability	4.705	**.030**
Energy saving materials and installations	2.253	.153
Cost overruns	1.087	.288
Poor competency of laborers	.322	.560
Jobsite cleanliness during projects and upon leaving jobsites	.917	.384
Safety consciousness on the job site	9.293	**.002**
Not buying insurance for major equipment and employees	.002	.957
Suppliers incompetency to deliver materials on time	3.418	.065
Failure to comply with the quality specifications	4.395	**.043**
Lack of readily available utilities on site	2.227	.129
Flexibility and cooperation when resolving delays	.658	.414
Knowledge of construction regulations	2.381	.123

- The performance issues during the projects are tested against the selection method of subcontractors. Performance issues are taken as test variables and selection method are group into 3 categories with minimum value of 1 to maximum value of 3.
- The Table 4.14 shows that quality performance has considerably higher mean rank for ‘lowest bid’ and ‘reference’. When general contractor uses this two method for subcontractor selection, they more likely to be concern about the quality performance. On the contrary, if contractor use experience as selection method they as less likely to be concern about the quality performance of the project.
- Subcontractor poor management ability has considerably higher mean rank for ‘lowest bid’ and ‘reference’. When general contractor uses this two method for subcontractor selection, they more likely to be concern about the Subcontractor poor management. On the contrary, if contractor use ‘experience’ as selection method they as less likely to be concern about the Subcontractor poor management ability.
- Safety consciousness on the job site has considerably higher mean rank for ‘lowest bid’ and ‘experience. When general contractor uses this two method for subcontractor selection, they more likely to be concern about the Safety on the site. On the contrary, if contractor use ‘reference’ as selection method they as less likely to be concern about the Safety consciousness on the job site.
- Failure to comply with the quality specifications has considerably higher mean rank for ‘lowest bid’ and ‘reference’. When general contractor uses this two

method for subcontractor selection, they more likely to be concern about this performance issue. On the contrary, if contractor use ‘experience’ as selection method they as less likely to be concern about the performance issue of Failure to comply with the quality specifications.

Table 4.14 Kruskal-Wallis test rank between performance & selection method of subcontractor

Performance Issues	Selection method of subcontractor	N	Mean Rank
Importance of the schedule performance	Lowest bid	11	22.09
	Reference	17	15.97
	Past experience	7	16.50
	Total	35	
Importance of the quality performance	Lowest bid	11	19.50
	Reference	17	20.03
	Past experience	7	10.71
	Total	35	
Ability to control the costs	Lowest bid	11	15.45
	Reference	17	19.50
	Past experience	7	18.36
	Total	35	
Sub-contractor’s poor management ability	Lowest bid	11	17.73
	Reference	17	20.79
	Past experience	7	11.64
	Total	35	
Energy saving materials and installations	Lowest bid	11	21.50
	Reference	17	16.59
	Past experience	7	15.93
	Total	35	
Cost overruns	Lowest bid	11	20.45
	Reference	17	17.21
	Past experience	7	16.07
	Total	35	

Poor competency of laborers	Lowest bid	11	16.64
	Reference	17	18.76
		7	18.29
	Past experience		
	Total	35	
Jobsite cleanliness during projects and upon leaving jobsites	Lowest bid	11	20.00
	Reference	17	17.50
	Past experience	7	16.07
	Total	35	
Safety consciousness on the job site	Lowest bid	11	23.45
	Reference	17	12.94
	Past experience	7	21.71
	Total	35	
Not buying insurance for major equipment and employees	Lowest bid	11	18.09
	Reference	17	17.97
	Past experience	7	17.93
	Total	35	
Suppliers incompetency to deliver materials on time	Lowest bid	11	21.36
	Reference	17	14.94
	Past experience	7	20.14
	Total	35	
Failure to comply with the quality specifications	Lowest bid	11	17.45
	Reference	17	20.76
	Past experience	7	12.14
	Total	35	
Lack of readily available utilities on site	Lowest bid	11	19.68
	Reference	17	15.53
	Past experience	7	21.36
	Total	35	
Flexibility and cooperation when resolving delays	Lowest bid	11	16.27
	Reference	17	18.32
	Past experience	7	19.93
	Total	35	
Knowledge of construction regulations	Lowest bid	11	14.45
	Reference	17	18.91
	Past experience	7	21.36
	Total	35	

CHAPTER 5

DISCUSSION, CONCLUSION & RECOMMENDATION

This chapter presents the conclusion and recommendations that arise from the study. Furthermore, the directions of future studies in the same field are also presented.

5.1 DISCUSSION

Subcontracting can be generally described as the practice of assigning part of the obligations and tasks under a contract to another party known as a subcontractor. Subcontracting is especially prevalent in areas where complex projects are the norm, such as construction. Subcontractor are hired by the project's general contractor, who continues to have overall responsibility for project completion and execution within its stipulated parameters and deadlines. Subcontracting therefore is an integral part of any construction industry particularly in a developing country like Saudi Arabia where there are massive constructions projects to be handled in the future.

Aim of this study was to investigate the subcontractor selection criteria from contractors' perspective.

Literature review was conducted to determine the different subcontractor selection criteria that are suitable for the construction industry in Saudi Arabia. A questionnaire was developed to collect the required data from different building contractors in the

Eastern Province of Saudi. The questionnaire was taken to all the building contractors of grade 1, 2 and 3 present in the Eastern Province of Saudi Arabia as per classified by the ministry of municipality and rural affairs.

5.1.1 SUBCONTRACTING CONSTRUCTION PROJECTS

Majority of the contractors regardless of time in construction market are subcontracting the projects and keeping it in their business operation. As the sign of success, the contractors want to give projects to only the organizations which have a past track record of successful projects in construction industry. The type of work subcontracted is varied among different contractors as majority gives site construction work to the subcontractor followed by material and construction equipment's.

Defining the scope of the subcontract entails splitting the project tasks into smaller units with each unit forming a separate subcontract. The number of subcontract formed depends on how large the scope of the subcontract, smaller scopes results in fewer subcontracts and vice-versa. The factors related to scope and number of contracts includes capabilities and workload of subcontractor, capabilities and work load of supplier, financing requirement, economies of scale, associated risks and liability exposure and contractor's current capability. Others are timing issues (project schedule), technological requirements/work sophistication, work interface requirements and contractor's tendency to involve in the works(Thomas, Asce, & Flynn, 2011b).

Majority of contractors regardless of the size of project are subcontracting the work all projects irrespective of the cost, time and size throughout the life cycle of the project due

to long term cost savings and subcontractor are quick and more competent in short projects whereas the contractor can manage the complexities of the projects(Zadan Hatush, 1997).

5.1.2 SUBCONTRACTOR SELECTION CRITERIA

Analyzing the received data from the by participants, the subcontracting criteria related to quality, financial, performance, technical abilities, etc. through SPSS software, the correlation coefficient and significance value for each criteria was found out. In financial, tender price of the project and financial stability of the subcontractor are considered to be the most important criteria for their selection. Banking arrangements and bonds were equally considered to be important in financials considerations of the subcontractor.

In technical ability category, experience and 'plant and equipment' have the highest median of 4. The contractor considers the capabilities of the subcontractor/supplier to handle each subcontract. Capabilities in terms of their experience, their possession of necessary equipment's and plants required in the construction operation, whether they are licensed to carry out certain proprietary activities. The selection method based on, the number of main contractors performing the selection process by means of 'a mixed group of technical and managerial personnel' who should be the real decision-makers is as low as 37.5% (Ulubeyli, Manisali, & Kazaz, 2010). Building projects doesn't require a highly technical approach, that's why general contractors think that experience plays a Vitol role in subcontracting the project.

In reputation category, it can also extend to their background check on whether they have successfully completed similar works. The past performance has the median value of 4 along with length of time in construction business. All these will determine the level of confidence the contractor will develop in the ability of the subcontractor in the hitch-free and timely completion of the subcontract which will greatly influence the risks attached to the work by the contractor. In a situation when the above mentioned conditions favor the prospective subcontractor, the contractor may go ahead by awarding that 'unit of work' as a subcontract. However, if reverse is the case, the 'unit of work' in question will have to be broken down into smaller scopes (which implies more number of subcontracts) or allocation of higher risks etc. to the concerned work item. This high reputation may have been created by excellent project management and prompt periodical payments to subcontractors(Tserng & Lin, 2002). It also indicates that no subcontractor depends on only one general contractor in obtaining work. This good relationship is supported by the sub- mission of quotations to all general contractors by the majority of subcontractors (Shash, 1998).

In addition to fulfilling the above mentioned conditions, the workload of the subcontractor is also of utmost importance, this is because the resources (human, capital, machineries) etc. of a subcontractor which are on use on a project cannot be simultaneously utilized on a different project. Even when such subcontractor is eventually allotted the subcontract, he may likely sublet it again to other subcontractor or cause delay in the project execution.

In safety category, safety and OSHA incident rate has the highest median value of 4 and was considered to be the important criteria for subcontracting selection. In making selection decisions of subcontractors, construction researchers call for an evaluation that is based on a set of criteria such as failure to adhere to subcontract provisions, safety record (incident rate), and non-adherence to relevant environmental regulations(Mashaleh, 2011). As per safety, virtually all general contractors have a requirement for their subcontractor work in a safe manner and to conduct their on-site operations in compliance with relevant safety codes and laws. Because the general contractor typically bears the burden to ensure the safety on the jobsite, virtually all general contractors require that their subcontractor actively participate in the safety management on the jobsite (Mccord, 2010).

In financial category, tender price financial stability, financial status and banking arrangements & bonding all have the median value of 4. Construction projects gulps huge amount of money, in most cases, third parties like banks and other financial institutions provides the required financial backing to the contractor. Financial status is important, as the general contractor does not want a subcontractor to go bankrupt. Bankruptcy can happen in as little as 6 months; all it takes is one bad project(Thomas et al., 2011b).

As banking and bonds are part of the risk management, according to (Arditi et al., 2005b) subcontractor bonds are “sometimes” required by general contractors because such bonds are normally required only on large construction projects or projects that involve high risks, particularly with subcontractor default. This result is in agreement with (Hinze j,

1994) which found that 68% of subcontractor were infrequently required to provide bonds.

In considering the financial requirement of a project, the contractor examines the funding options available and their guidelines carefully with a view to making an optimum choice. In some cases, the financing body will stipulate the minimum or maximum value of work the contractor should accomplish in-house or sublet. Diverse reasons often accounts for this, it may be to solicit an absolute commitment of the parties (contractor, subcontractor) to a speedy and successful completion of the project, to spread the risks, to fulfill certain governmental regulations etc.(Wang & Liu, 2005).

In situations when the contractor thinks he has the ability to control the cost, he may prefer to choose a form of reimbursable contract as the pricing approach in order to save some cost to himself; otherwise he chooses any other pricing approaches. The contract award method (competitive bidding or negotiation) also plays a major role in the choice of the pricing approach. In fact, some awarding methods are more favorably disposed to a particular approach to an extent that people often think they must be used together e.g. LSTK – lump sum turnkey is popular among contractors, the pricing approach is lump sum while the award method is turnkey.

5.1.3 CORRELATION WITH PERFORMANCE

The bivariate spearman's correlation was done to know the criteria significance with different performance issues during project execution. There were only 6 such selection

criteria which were affected by 3 or more performance issues. They are discussed below with selection criteria.

Tender price is the price offered by the subcontractor to win the tender. The tender price should not be the main criteria based on which the selection process occurs. The general contractor thinks that quality performance, lack of readily available utilities and flexibility in resolving delays are significant performance issue when they take tender price as important selecting criteria. This was highly supported by the study from (Marzouk et al., 2013) which states tender price as the decision making process for most of the projects. The demand on trained personnel refers to the technical qualifications of the people performing the measurement and the data analysis(Abu-Asbah,M 1994). Thus quality of the project differs from having the trained personnel in the organization.

The contractors when take *personnel* as significant selecting criteria, they are more likely to consider quality performance, incompetency of labors & site cleanliness as important performance issue during the project execution. Frequent changes in project management personnel may also prevent some implicit knowledge gained from a project from being utilized in the future. The use of a database management system utilizing knowledge management techniques will assist the contractor in a long way to abort most of the issues emanating from lack of information/imprecise data from previous practices. Both the cost and schedule performance of the project are negatively impacted by the problem of lack of information/imprecise data from previous practices(Zou & Lim, 2006). The problems related to planning issue include inadequate planning of subcontracting practices, incompatibility of the subcontractor/ supplier's time schedule with the project's

time schedule, lack of information/imprecise data from previous practices, too much interfaces between subcontractor/suppliers works and insufficient period/squeezed schedule for subcontract's arrangement activities(Yik & Lai, 2008). The overall negative effects of insufficient period/squeezed schedule for subcontract's arrangement activities manifest etc. Insufficient period/squeezed schedule for subcontract's arrangement activities often results from lack of subcontracting plan, short time interval between the award of contract and the commencement of work on site, utilization of time reduction project management strategies such as fast tracking etc. The effect is notably felt negatively on the cost performance of the project.

The contractors when giving importance to *project management organization* as important selecting criteria takes, ability to control cost, subcontractors poor management ability and jobsite cleanliness as significant performance issue during execution of the project. Management and coordination problems which occur on construction site directly impact schedule performance of a project negatively, on the long run they may negatively impact the cost and quality performance of a project as well. They are deeply rooted in lack of project management skills, knowledge and experience of construction project managers. They manifest within all phases of the project life cycle and their effect may be specifically pronounced during the contracting phase of the subcontract. Good recordkeeping and the use of project management tools and software can drastically reduce their occurrence. Most contractors are plagued with poor record keeping system which prevents them from having a database of lesson learnt from previous projects. Worse still, some contractors have not yet realized the need to have such system in place

while some displays non-chant attitude towards the closing out phase of projects when such information ought to have been documented.

The contractors while taking the *geographic location* as significant selecting criteria for subcontractor selection consider importance of schedule performance, energy saving materials & installation, cost overruns and jobsite cleanliness as significant performance issue during the project execution. The subcontractors and consequently their surrounding in industrial districts is not a feature specific to any of the subcontractor clusters(Rahman, 2009). This makes sense since industrial districts are extremely diverse, in nature and structures, even in the same region.

General scope of work or scope of work allotted to the subcontractor may equally complicate the problem while the seasonal variation in the volume of construction works due to harsh weather etc. This restricts the flexibility of some subcontractor and thus constitute to the incompatibility of their schedules with the project time schedule. Both the schedule and cost performance of a project are negatively impacted by the incompatibility of the subcontractor/supplier's schedule with the project's time schedule (Packham, Thomas, & Miller, 2003).

The contractor when taking industrial relation as significant selecting criteria for subcontractor takes performance issues like subcontractors poor management ability, energy saving material and installation and cost overruns as important during the project execution. The subcontractor will obviously will try to maintain good relation in the market by taking projects from every corner and sometimes simultaneously doing more

projects at a time. They also try to satisfy all of them within their limited resources. Late communication of the project's master schedule by the contractor to the subcontractor.

Some project management strategy like crashing, fast tracking, resource leveling by any of the subcontractor can initiate interface problem when not properly monitored. Poor communication also manifests as a result of lack of coordination and can worsen the matter. Some other likely causes of interface problems includes; inaccurate estimation of duration leading to extension of time, inaccurate estimation of quantity of works which results in having more volume of work than expected, lateness in getting approvals for some work items, lateness in getting results of tests e.g. soil tests for foundation purposes, lateness in delivery of essential materials needed for job, lateness in clearance of exported materials from the port(Paul Humphreys, Jason Matthews, 2003). All these causes delay which might cause interface problems thereby impacting schedule and cost performance of the project negatively.

Performance history also remains a major criterion in the evaluation of subcontractor/suppliers. When this is not available and the contractor based his decision on other factors, he may have chosen an inappropriate subcontractor/supplier evaluation criteria and compromise quality standard on the job. This may impact the quality performance on the job negatively.

5.2 CONCLUSION

Every project in Saudi Arabia is subcontracted whether it's a small or large and selection process for subcontractor is varies from different contractors. The subcontractor selection

criteria are of utmost important to every contractor as it will remove the unwanted subcontractor from the list. Many contractors think that past experience and financial stability of the subcontractor are the utmost important to them. Experience management in the organization will be an additional importance the subcontractor selection. Majority of the contractors are using past experience as the subcontractor selection method.

All subcontractor are not appropriate for all jobs, some are befitting for specific project size within a certain price range. Subcontractor selection criteria often used include price, past performance, health and safety record, financial capability, current workload, reputation, past relationships, resources (physical and human), technical and managerial capability, numbers of years of experience, references, location of firm, firm's experience of similar projects and appropriate insurance cover. The list could be in exhaustive depending on type / size/ nature of the project, the awarding method, the pricing approach etc.

The above makes the subcontractor selection more of art than science; in fact none of the numerous objective selection models developed by researchers has been identified to be all-embracing for different situations. Despite this the contractor has to ensure the use of appropriate criteria, giving necessary priority to the prevailing factors to select subcontractor/suppliers as a wrong choice of subcontractor could result in higher capital cost of construction operations, unnecessary request for extension of time, reduced quality of workmanship etc. thereby impacting the cost, schedule and quality performance of the project negatively.

The cutoff mark of median 4 and the criteria which are affected with 3 or 4 performance issue during the project was taken as point of calculating the most significant subcontracting selection criteria. There were only three criteria among 28 that were surveyed by general contractors that satisfied such condition and they are *tender price, project management organization and length of time in business.*

5.3 RECOMMENDATION

In this section recommendation will be made to the further studies on the same subject which may help contractors to improve the subcontractor selection criteria and its practices in their organization. Recommendation for further studies will also be given which are required in the construction industry in Saudi Arabia.

5.3.1 RECOMMENDATION FOR GENERAL CONTRACTORS

- Contractors who are considering giving out project to subcontractor are advised to understand the importance of selection criteria before giving out the projects.
- Contractors are advised to look for experience subcontracting agencies as it was considered to be important by many general contractors in the survey.
- The contractors should look for subcontractors having good equipment and manpower.
- The contractors should read the financial stability of the subcontractors before giving the project.
- The contractors should look into the past projects of subcontracting agencies for knowing their understanding about the construction projects.

5.3.2 RECOMMENDATION FOR FURTHER STUDIES

- It can be recommended that a study could be carried out in future to determine the barriers which the contractors consider and face in selecting subcontractor.
- It is recommended to find out the selection criteria for other construction projects like industry public utilities, etc.

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APPENDIX

APPENDIX A: QUESTIONNAIRE

KING FAHD UNIVERSITY OF PERTROLEUM& MINERALS

CONSTRUCTION ENGINEERING AND MANAGEMENT DEPARTMENT

SURVEY ON SUBCONTRACTING SELECTION CRITERIA FOR CONSTRUCTION PROJECTS IN SAUDI ARABIA

Dear respondent,

A study is being conducted on subcontracting selection criteria for construction projects in Saudi Arabia. *As a leading Contractor in the Saudi Arabia, your company is selected to participate in the study. The objective of the study is to investigate the criteria for subcontractor selection in construction Projects. The Questionnaire is designed for Construction Management Personnel (i.e. Construction/Project Managers, Job Superintendent, Project Engineers etc.) who have hands-on experience in subcontracting practices.*

The Questionnaire is divided into two sections and should take less than 10 minutes of your valuable time to complete. The information that you provide shall be kept strictly confidential and shall be used only for research purpose and will be presented in the research in aggregate. Your contribution towards this study is greatly appreciated, as it will add significantly to the value of the research and the research results will be of great benefits to the industry including your organization.

Thank you in anticipation of your cooperation.

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SECTION 1: About Organization

This section collects basic information about your organization.

1. Name of the Organization:
   ……

2. Number of Employees:

   ☐ Less than 50 ☐ between 100- 500 ☐ between 500- 1000

   ☐ between 1000-1500 ☐ 1500 or more

3. From how many years your organization is in market?

   ☐ Less than 5 ☐ between 5-10 ☐ between 10-15

   ☐ between 15-20 ☐ 20 or more

4. How many Projects did your organization completed in last 5 years?

   ☐ Less than 5 ☐ between 5-15 ☐ between 15-20

   ☐ between 20-30 ☐ 30 or more

5. What type of utilities does your organization builds? (can select more than one)

   ☐ Industrial ☐ Residential ☐ Public Utilities

   ☐ Commercial ☐ others, please specify …….

6. Who are your organization's clients?

   ☐ Private Sector ☐ Government Sector ☐ Both

   ☐ Others, please specify …….

SECTION 2: About Respondent

This section collects basic information about respondent of this questionnaire

1. Name: ……..
2. Job Title: …….
3. What is your education level?

☐ Diploma (ITI) ☐ Bachelor Degree ☐ Master Degree

☐ PhD ☐ others, please specify ……..…..

4. How many years have you been working with the present organization?

☐ Less than 3 ☐ between 3-5 ☐ between 5-10

☐ between 10-15 ☐ 15 or more

5. Your total experience in construction Industry?

☐ Less than 5 ☐ between 5-10 ☐ between 10-15

☐ between 15-20 ☐ 20 or more

SECTION 3: About Subcontracting

This section collects basic information about subcontracting in your organization.

1. Does your organization subcontracts the work? Yes…… No ……
2. How long has your organization been subcontracting the work?

☐ Less than 5 years ☐ between 5-10 years ☐ between 10-15 years

☐ between 15-20 years ☐ more than 20 years

3. How does your organization select the subcontractor?

☐ Lowest Bid ☐ Reference ☐ Past Experience

☐ others, please specify ……..

4. On which project does your organization subcontracts?

☐ Small projects ☐ Medium Projects ☐ Large Projects

☐ Every Project

5. What percentage (%) of project is subcontract by your organization?

☐ 0-20 ☐ 20-40 ☐ 40-60

☐ 60-80 ☐ 80-100

6. What kind of work is subcontracted by your organization?(can select more than one)

☐ Site construction ☐ Material ☐ Electrical /mechanical

☐ Construction Equipment's ☐ Others, please specify
…….

SECTION 4: SUBCONTRACTOR SELECTION CRITERIA

You are kindly requested to rate the importance of the criteria for subcontractor selection on a Likert scale of 1 to 5, The corresponding scale shall be 1= Not important; 2= Slightly important; 3= Moderately important; 4= Highly important and 5= extremely important. Check √ in the appropriate box.

Subcontractor selection criteria	**1**	**2**	**3**	**4**	**5**
Quality					
Quality performance (e.g. ISO 9000 accreditation)					
Financial soundness					
Financial stability.					
Tender price					
Credit rating					
Banking arrangements and bonding					
Financial Status					
Technical ability					
Experience					
Plant and equipment.					
Personnel					

Subcontractor selection criteria	**1**	**2**	**3**	**4**	**5**
Ability					
Management capability					
Past performance and quality					
Project management organization.					
Performance history					
Geographical location					
Physical size/growth					
Experience of technical personnel					
Management knowledge					
Health & Safety					
Safety					
Experience modification rating					
OSHA Incident rate.					
Management safety accountability					

Subcontractor selection criteria	**1**	**2**	**3**	**4**	**5**
Reputation					
Past failures.					
Length of time in business					
Past owner/contractor relationship.					
Scale of projects completed					
Amount of past business					
Industrial relations					
Cultural similarity					

Performance Issue During Project

Importance of the schedule performance					
Importance of the quality performance					
Ability to control the costs					
Sub-contractor’s poor management ability					
Energy saving materials and installations					

Cost overruns					
Poor competency of laborers					
Jobsite cleanliness during projects and upon leaving jobsites					
Safety consciousness on the job site					
Not buying insurance for major equipment and employees					
Suppliers incompetency to deliver materials on time					
Failure to comply with the quality specifications					
Lack of readily available utilities on site					
Flexibility and cooperation when resolving delays					
Knowledge of construction regulations					

APPENDIX B: ANALYSIS RESULTS

	Mean	Median	Mode	Std. Deviation
Quality performance	3.8286	4.0000	4.00	.61767
Financial stability	3.7714	4.0000	4.00	.77024
Tender price	3.9714	4.0000	4.00	.92309
Credit rating	3.5143	3.0000	3.00	.88688
Banking arrangements and Bonding's	3.6857	4.0000	4.00	.90005
Financial status	3.7714	4.0000	3.00	.94202
Experience	4.2286	4.0000	4.00	.73106
Plants and equipment	4.1429	4.0000	4.00	.80961
Personnel experience	3.6857	3.0000	3.00	.96319
Personnel Ability or skills	3.5429	3.0000	3.00	.85209
Past performance	3.8000	4.0000	4.00	.75926
Project management organization	3.6000	4.0000	4.00	.81168
Performance history	3.2571	3.0000	3.00	.74134
Geographical location	3.1143	3.0000	3.00	.93215
Size and growth	3.4000	3.0000	3.00	.73565
Experience of technical personnel	3.5714	3.0000	3.00	.69814
Management knowledge	3.2286	3.0000	3.00	.64561
Safety System	3.9143	4.0000	5.00	.98134
Experience modifications rating	3.3143	3.0000	3.00	.99325
Osha incident rate	3.6857	4.0000	4.00	.90005
Management safety Accountability	3.3143	3.0000	3.00	.86675
Past failures	3.4571	3.0000	3.00	1.01003
Length of time in business	3.6571	4.0000	4.00	.93755
Past owner /contractor Relationships	3.3143	3.0000	3.00	.75815
Scale of project completed	3.3429	3.0000	4.00	.87255
Amount of past business	3.2286	3.0000	3.00	.87735
Industrial relation	2.9714	3.0000	3.00	.98476
Cultural similarity	2.5714	2.0000	2.00	1.03713

APPENDIX C: CODES FOR PERFORMANCE ISSUES

Code	Performance
P1	Importance of the schedule performance
P2	Importance of the quality performance
P3	Ability to control the costs
P4	Sub-contractor's poor management ability
P5	Energy saving materials and installations
P6	Cost overruns
P7	Poor competency of laborers
P8	Jobsite cleanliness during projects and upon leaving jobsites
P9	Safety consciousness on the job site
P10	Not buying insurance for major equipment and employees
P11	Suppliers incompetency to deliver materials on time
P12	Failure to comply with the quality specifications
P13	Lack of readily available utilities on site
P14	Flexibility and cooperation when resolving delays
P15	Knowledge of construction regulations

APPENDIX D: CODES FOR CRITERIA

Code	Criteria
C1	Quality performance (e.g. ISO 9000 accreditation)
C2	Financial stability.
C3	Tender price
C4	Credit rating
C5	Banking arrangements and bonding
C6	Financial Status
C7	Experience
C8	Plant and equipment.
C9	Personnel
C10	Ability
C11	Past performance and quality
C12	Project management organization.
C13	Performance history
C14	Geographical location
C15	Physical size/growth
C16	Experience of technical personnel
C17	Management knowledge
C18	Safety
C19	Experience modification rating
C20	OSHA Incident rate.
C21	Management safety accountability
C22	Past failures.
C23	Length of time in business
C24	Past owner/contractor relationship.
C25	Scale of projects completed
C26	Amount of past business
C27	Industrial relations
C28	Cultural similarity

VITAE

Meer Aijaz Ali was born in Hyderabad, India on October 30, 1989. He obtained Bachelor of Engineer (B.E) in Civil Engineering from Osmania University, Hyderabad, India in 2012. He participated in SSC6 held in Jeddah, Saudi Arabia in March 2014 as entrepreneur with new technological idea of booking bus services in Saudi Arabia. He has worked with one of the top construction firms in India before joining King Fahd University Of Petroleum & Minerals, Dhahran, Saudi Arabia as Graduate student in September 2013.

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